Age and Duration of the British Tertiary Igneous Province: Implications for the Development of the Ancestral Iceland Plume

Lynne Marie Chambers

Figures and Appendices

Thesis submitted in fulfilment of the requirements for the degree of

Doctor of Philosophy (Ph.D.) in Geology

University of Edinburgh

2000

List of Figures

Page	Chapter 1
1	Figure 1.1. The location of large igneous provinces (LIPs), redrawn from Saunders *et al.* (1992)
3	Figure 1.2. A location map of the North Atlantic Igneous Province taken from Fitton *et al.* (1997)
4	Figure 1.3. A palaeogeographic reconstruction of the North Atlantic at Anomaly 24
5	Figure 1.4. A seismic tomography image of the present-day Iceland plume
6	Figure 1.5. Major element and trace element variations to the north and south of Iceland
7	Figure 1.6. The Zr-Y-Nb discrimination diagram of Fitton *et al.* (1997)
8	Figure 1.7. Variation in ΔNb with distance from the proposed plume centre at 58 Ma
9	Figure 1.8. A schematic diagram showing different models for plumes generated at thermal boundary layers within the mantle
	Chapter 2
10	Figure 2.1. A schematic diagram of the three plume models
11	Figure 2.2. Magmatism in the North Atlantic Igneous Province divided into two phases
12	Figure 2.3. A palaeogeographic reconstruction to Anomaly 24
13	Figure 2.4. $^{87}Sr/^{86}Sr$ versus $^{144}Nd/^{143}Nd$ for North Atlantic mid-ocean ridge basalt (MORB) and the Iceland neovolcanic zone
14	Figure 2.5. Variations in La/Sm and ΔNb down the Reykjanes Ridge
15	Figure 2.6. Variation in ΔNb with distance from the proposed plume centre

17 Figure 2.7. Summary diagrams showing the development of the rift system in the North Atlantic

19 Figure 2.8. Age dates summarised in Table 2.2 plotted onto the time scale of Berggren *et al.* (1995)

20 Figure 2.9. A location map of the British Tertiary Igneous Province

21 Figure 2.10. A simplified geological map of the Isle of Mull

22 Figure 2.11. Chronology and correlation of ash layers in Denmark and the North Sea

24 Figure 2.12. Magnetic polarity, geology and timing of individual centres in the British Tertiary Igneous Province

26 Figure 2.13. The radiometric ages detailed Table 2.3 shown on the geomagnetic time scale of Berggren *et al.* (1995)

Chapter 3

27 Figure 3.1. A J curve for irradiation EK33

29 Figure 3.2. Two schemes for the position of the monitor minerals used in this study

30 Figure 3.3. The position of the monitor minerals and unknowns during irradiation EK33

31 Figure 3.4. A J curve for irradiation EK33

32 Figure 3.5. Two schematic age spectra diagrams, one showing an undisturbed system where the $^{40}Ar/^{39}Ar$ ratio is constant showing that the system has been closed

33 Figure 3.6. Two age spectra from this study that show the effects of a closed system (A) and an open system (B)

34 Figure 3.7. An isochron plot with $^{40}Ar/^{36}Ar$ versus $^{39}Ar/^{36}Ar$

35 Figure 3.8. A schematic saddle shaped age spectra and corresponding isochron plot

36 Figure 3.9. An example age spectrum from this study showing the effects of argon recoil
37 Figure 3.10. A flow chart detailing the process of evaluating age spectrum and isochron ages
38 Figure 3.11. An element map for sample SB3 that yielded a good $^{40}Ar/^{39}Ar$ age
39 Figure 3.12. An element map for sample UBLFIBQ that showed the effects of argon recoil and alteration
40 Figure 3.13. A schematic diagram showing the copper pans used to irradiate single crystals
41 Figure 3.14. The J curve for irradiation EK29
41 Figure 3.15. The J curve for irradiation EK33
42 Figure 3.16. J values for monitor minerals in pan F, irradiation EK35
42 Figure 3.17. Monitor minerals located in hole 18 and a-h are shown on a plot of J with position
43 Figure 3.18. A parabaloid can be regressed through the monitor data.
44 Figure 3.19. The J values for pan F, irradiation EK 35
45 Figure 3.20. The a-h J values and the hole 18 J values are corrected for tilt
46 Figure 3.21. The J curve for EK37

Chapter 4

47 Figure 4.1. The flow chart used to summarise the decision making process involved in evaluating the age spectrum and isochron plots
48 Figure 4.2. The sample localities are shown on a simplified geological map of the Small Isles
49 Figure 4.3. Single crystal total-fusion isochrons for samples MT2 (top) and MT3 (bottom)

50	Figure 4.4. Example age spectrum diagrams for samples MT2 (top) and MT3 (bottom)
52	Figure 4.5. Whole rock age spectrum and isochron plots for sample T752 (lava from Muck), T908 (Lava from Eigg) and MKD1 (dyke Camas Mor, Muck)
53	Figure 4.6. Four Sgurr of Eigg sanidine incremental-heating age spectra
54	Figure 4.7. Incremental-heating age spectra for the glass from the Sgurr of Eigg pitchstone
55	Figure 4.8. Two age spectra for biotites from SR539 that were analysed by individual crystal incremental-heating
55	Figure 4.9. The age spectrum for sample SR475 analysed using the degassing and total-fusion method
56	Figure 4.10. Whole rock incremental-heating experiments for two samples, SR252 (Canna lava) and SR215 (Rum lava)
57	Figure 4.11. A simplified geological map of Skye
58	Figure 4.12. Whole rock incremental-heating experiments for three lava flows from Skye, SK139, SK137 and SK139
59	Figure 4.13. Whole rock (leached) incremental-heating experiments on two samples from Bracadale, Skye (SB3 and SB10)
60	Figure 4.14. Whole rock (leached) incremental-heating experiments on two dyke samples from Skye (SD1 an SD3)
61	Figure 4.15. An incremental-heating and a degassing and total-fusion experiment on riebeckite crystals from the Rudha Stac granite, Skye
62	Figure 4.16. Single crystal incremental-heating and degassing and total-fusion analysis on arfvedsonite from the Glamaig granite, Skye
63	Figure 4.17. Single crystal laser incremental-heating experiments on biotite crystals from the Loch Ainort granite, Skye
64	Figure 4.18. Combined degassing and total-fusion analysis on nine hornblende crystals from the Marsco granite

65 Figure 4.19. Single crystal incremental-heating analysis and degassing and total-fusion experiments on hornblende from the Glas Bheinn Mor granite, Skye
66 Figure 4.20. Degassing and total-fusions on biotite from the Beinn an Dubhaich granite, Skye
68 Figure 4.21. A simplified geological map of Mull
69 Figure 4.22. Three whole rock incremental-heating experiments on lava samples from Mull (B1, T1 and T3)
70 Figure 4.23. Three whole rock incremental-heating experiments on a basal lava (BB6) and two lava flows from a height of ~700m in the Ben More succession in Mull (BM64 & BM67)
71 Figure 4.24. Two whole rock incremental-heating experiments on samples SO17 and SO33
72 Figure 4.25. Whole rock and sanidine incremental-heating experiments on samples from the Loch Ba ring dyke, Mull
73 Figure 4.26. Scanning electron microscope image of the whole rock sample from the Loch Ba ring dyke showing a groundmass of quartz and feldspar
74 Figure 4.27. Two whole rock incremental-heating experiments and one felsic concentrate incremental-heating experiment on samples MD1-3.
76 Figure 4.28. Simplified geological map of Northern Ireland
77 Figure 4.29. Whole rock incremental-heating experiments on samples A2 and PNB6 from the Antrim plateau basalts
78 Figure 4.30. Whole rock incremental-heating experiments for samples BVA0 and BVA3 from the Antrim plateau basalt sequence
79 Figure 4.31. Single crystal laser incremental-heating experiments on sanidine from the Sandy Braes obsidian, Antrim
80 Figure 4.32. Laser incremental-heating experiments for two glass samples from the Sandy Braes obsidian

81 Figure 4.33. Single crystal laser incremental-heating experiments on sanidine from the Tardree rhyolite

82 Figure 4.34. Whole rock incremental-heating experiments on two Antrim Lower basalt samples (NEWBMQ and GBY5)

83 Figure 4.35. Whole rock incremental-heating experiments on two Upper basalt samples from Antrim (AGH4 and UBLFIBQ)

84 Figure 4.36. Single crystal laser incremental-heating experiments on biotite from the Mourne Mountains granite number 1

86 Figure 4.37. Simplified geological map of Ardnamurchan.

87 Figure 4.38. Laser incremental-heating experiments on four biotite crystals from a Centre 3 biotite gabbro, Ardnamurchan

88 Figure 4.39. Whole rock incremental-heating experiment on sample AD20

90 Figure 4.40. The location of sample A3 is shown on a simplified geological map of Arran

91 Figure 4.41. Examples of single crystal incremental-heating experiments on biotites for the North Arran granite

93 Figure 4.42. A map of West of Shetland showing the location of the samples analysed as part of this study

94 Figure 4.43. Whole rock incremental-heating experiments for a sample from Rockall (A) and a sample from Anton Dorhn (B)

95 Figure 4.44. Whole rock incremental-heating experiment on a dyke from the Anglesey swarm (3317)

97 Figure 4.45. Published ages for the BTIP prior to this study (Table 2.2, Chapter 2) plotted on the timescale of Berggren *et al.* (1995)

98 Figure 4.46. The new $^{40}Ar/^{39}Ar$ ages from this study plotted on the geomagnetic timescale of Berggren *et al.* (1995)

Chapter 5

101 Figure 5.1. The magnetic polarity data for the Small Isles (Dagley and Mussett., 1981, 1986), the $^{40}Ar/^{39}Ar$ dates from this thesis and the U/Pb

ages from Hamilton *et al.* (1998) are shown on the geomagnetic timescale of Berggren *et al.* (1995)

103 Figure 5.2. Data from the summary table for Skye (Table 5.2) is correlated to the geomagnetic timescale of Berggren *et al.* (1995)

105 Figure 5.3. A simplified schematic diagram showing stratigraphic relationships in the Mull central complex

106 Figure 5.4. New $^{40}Ar/^{39}Ar$ dates for Mull (Chapter 4) tie the stratigraphy and magnetic changes to the geomagnetic timescale of Berggren *et al.* (1995)

108 Figure 5.5. The changes in magnetic polarity seen in Arran are tied to the timescale of Berggren *et al.* (1995)

110 Figure 5.6. The rocks of the Tertiary igneous centre of Ardnamurchan plot within Chron 26r

112 Figure 5.7. Radiometric ages from this study, Gibson *et al.* (1995), Gamble *et al.* (1999) and Thompson (1986) are used to correlate the magmatic history of Antrim to the geomagnetic timescale of Berggren *et al.* (1995)

114 Figure 5.8. Two models showing the possible correlations of Skye and Mull to the geomagnetic timescale of Berggren *et al.* (1995)

115 Figure 5.9. Seafloor magnetic records from the Pacific and Indian oceans between Chron 26n and Chron 27n, redrawn from Cande and Kent (1992b)

115 Figure 5.10. Calibration points and magnetic anomalies are shown on a distance versus age plot, redrawn from Cande and Kent (1992b)

116 Figure 5.11. Comparison of the pattern of tiny wiggles in three seafloor spreading records that have been stretched to a common width, redrawn from Cande and Kent (1992b)

Chapter 6

117 Figure 6.1. Zr/Y and Nb/Y variation in basalts from the neovolcanic zone in Iceland and normal segments of mid-ocean ridge (Fitton *et al.*, 1997)

118 Figure 6.2. Variation in $^{87}Sr/^{86}Sr$ and $^{143}Nd/^{144}Nd$ in lavas from the Iceland neovolcanic zone and the BTIP

119 Figure 6.3. Variation in Ba/Zr and ΔNb in lavas from the Small Isles, Mull, Skye, and Arran

120 Figure 6.4. Variation in Ce/Y and ΔNb in lavas from the Small Isles, Ardnamurchan, Skye and Arran

121 Figure 6.5. Variation in Ba/Zr and ΔNb in samples from the worlds ocean island basalts (OIB)

122 Figure 6.6. Variation in ΔNb, Zr/Y, Ba/Zr and Ce/Y with stratigraphic height in the Beinn Reudle section of Kerr (1993,1995)

123 Figure 6.7. Sample localities in the Small Isles are shown on a simplified geological map

124 Figure 6.8. Basalts from the Small Isles samples define an array within the N-MORB field on a Zr/Y versus Nb/Y discrimination diagram

124 Figure 6.9. The Small Isles samples divided into 5 stratigraphic groups

125 Figure 6.10. Sample localities are shown on a simplified geological map of Ardnamurchan

126 Figure 6.11. Basalt samples from Ardnamurchan plotted on a Zr/Y versus Nb/Y discrimination diagram

127 Figure 6.12. Sample localities are shown on a simplified geological map of Arran

128 Figure 6.13. The Arran dykes plot within the Iceland and N-MORB arrays on a Zr/Y versus Nb/Y discrimination diagram

129 Figure 6.14. Basalt dykes with known magnetic polarity (Robertson, 1999) are shown on a Zr/Y versus Nb/Y diagram and a plot of Ba/Zr versus ΔNb

130 Figure 6.15. Basalt samples from Antrim, divided into the three formations of Wilson and Manning (1978) are plotted on a Zr/Y versus Nb/Y diagram

131 Figure 6.16. (A) Variations in ΔNb and height in the Antrim plateau basalt succession

132 Figure 6.17. Variations in ΔNb down the Reykjanes Ridge, redrawn from Fitton *et al.* (1997)

133 Figure 6.18. Sample localities are shown on a simplified geological map of Skye

134 Figure 6.19. Basalts from Skye plotted on a Zr/Y versus Nb/Y diagram

134 Figure 6.20. Samples divided using the scheme of Williamson and Bell (1994) are plotted on a ΔNb versus relative height diagram

135 Figure 6.21. The dyke and Cuillin gabbro samples are shown on Zr/Y versus Nb/Y diagram and a plot of Ba/Zr versus ΔNb

136 Figure 6.22. A simplified geological map of Mull

137 Figure 6.23. Mull and Staffa basalt samples plotted on the Zr/Y versus Nb/Y discrimination diagram of Fitton *et al.* (1997)

138 Figure 6.24. Variations in ΔNb, Zr/Y, Ce/Y, MgO, Ti/Zr with height for the Ben More and Beinn na h-Iolaire sections of Kerr (1995), redrawn from Chambers and Fitton (2000)

139 Figure 6.25. Samples from the Corra Bheinn layered gabbro (Chambers, 1996), the lavas with normal magnetic polarity and the late dykes are shown on a plot of Zr/Y versus Nb/Y and Ba/Zr versus ΔNb

140 Figure 6.26. Offshore samples plotted on a Zr/Y versus Nb/Y diagram

141 Figure 6.27. The offshore samples from West of Shetland divided into the 2 phases of Saunders *et al.* (1997)

142 Figure 6.28. Variation in Zr/Nb with depth in tuffs from the North Sea.

142 Figure 6.29. Variation in Zr/Nb with depth in tuffs from West of Shetland

143 Figure 6.30. Variation in Zr/Nb and layer number in tuffs from the Danish Fur Formation

144 Figure 6.31. A Nb (ppm) versus Zr (ppm) plot showing the Danish ashes (DK), North Sea tuffs, West of Shetland tuffs and the East Iceland Tertiary basalts (G. Fitton, unpublished data)

145 Figure 6.32. Anglesey dyke samples plotted on a Zr/Y versus Nb/Y diagram

146 Figure 6.33. Stratigraphic variations in ΔNb correlated to the geomagnetic timescale of Berggren *et al.* (1995)

147 Figure 6.34. Variation in ΔNb and Ti/Zr through the Mull plateau lava succession

148 Figure 6.35. Variation in Ti/Zr with ΔNb in the Mull, Skye and Antrim lava successions

Chapter 7

150 Figure 7.1. Existing radiometric ages for the BTIP, available prior to this study, are correlated to the geomagnetic time scale of Berggren *et al.* (1995)

151 Figure 7.2. The new $^{40}Ar/^{39}Ar$ ages for the BTIP presented in this thesis are correlated to the geomagnetic time scale of Berggren *et al.* (1995)

152 Figure 7.3. Radiometric ages for the NAIP (Chapter 2) including some of the new data presented within this thesis (Chapter 4) are correlated to the geomagnetic time scale of Berggren *et al.* (1995)

153 Figure 7.4. Two models that seek to account for the presence of normal polarity events within Chron 26r

154 Figure 7.5. Variations in Ba/Zr with ΔNb in Mull, Skye, the Small Isles and Arran

155 Figure 7.6. Variations in Ti/Zr with ΔNb in the Small Isles, Skye and Mull

156 Figure 7.7. Stratigraphic changes in ΔNb are correlated to the geomagnetic time scale of Berggren *et al*. (1995)

Chapter 8

157 Figure 8.1. A schematic diagram showing the development of the BTIP with respect to the underlying mantle plume

List of Tables

Page	Chapter 1
2	Table 1.1. A summary of the location, age and size of five large igneous provinces
4	Table 1.2. Dimensions of the North Atlantic Igneous Province taken from Richards *et al.* (1989)
	Chapter 2
16	Table 2.1. Geological development of the Vøring Margin
18	Table 2.2. Some of the available age dates for samples from the North Atlantic Igneous Province
23	Table 2.3. A summary table of the most recent published radiometric ages for the British Tertiary Igneous Province
25	Table 2.4. Stratigraphic relationships between individual centres of the British Tertiary Igneous Province
	Chapter 3
28	Table 3.1. Details of reactions that generate interfering isotopes during the irradiation of a sample
28	Table 3.2. Correction factors for the K and Ca derived isotopes during irradiation at the USGS TRIGA reactor, USA, and the Petten RODEO reactor in The Netherlands
46	Table 3.3. An explanation of experiment numbers used in the next chapte
	Chapter 4
51	Table 4.1. $^{40}Ar/^{39}Ar$ age results for samples from the Small Isles
67	Table 4.2. $^{40}Ar/^{39}Ar$ dating results on samples from Skye
75	Table 4.3. $^{40}Ar/^{39}Ar$ dating results on samples from Mull

85 Table 4.4. $^{40}Ar/^{39}Ar$ dating results for samples from Antrim and Ireland

89 Table 4.5. $^{40}Ar/^{39}Ar$ dating results for the Ardnamurchan samples

92 Table 4.6. Ar-Ar dating results for the North Arran granite

96 Table 4.7. $^{40}Ar/^{39}Ar$ dating results for samples from Rockall and Anton Dorhn

99 Table 4.8. The new $^{40}Ar/^{39}Ar$ ages from this study for the BTIP

Chapter 5

100 Table 5.1. A summary of the magmatic history of the Small Isles is combined with the $^{40}Ar/^{39}Ar$ ages from this thesis and Hamilton *et al.* (1998)

102 Table 5.2. A summary table combining the magmatic history of Skye

104 Table 5.3. The igneous succession in Mull

107 Table 5.4. A summary of the magmatic history, magnetic polarity and radiometric age for the Isle of Arran

109 Table 5.5. The complex igneous history of Ardnamurchan

111 Table 5.6. The Antrim plateau basalts are subdivided into Lower, Middle and Upper Formations

113 Table 5.7. The location of the samples collected by the British Geological Survey and their magnetic polarity

Chapter 6

149 Table 6.1. Summary table of changes in ΔNb, $^{40}Ar/^{39}Ar$ geochronology and magnetic stratigraphy in the BTIP

Chapter 8

158 Table 8.1. A summary table of all of the $^{40}Ar/^{39}Ar$ ages presented in Chapter 4

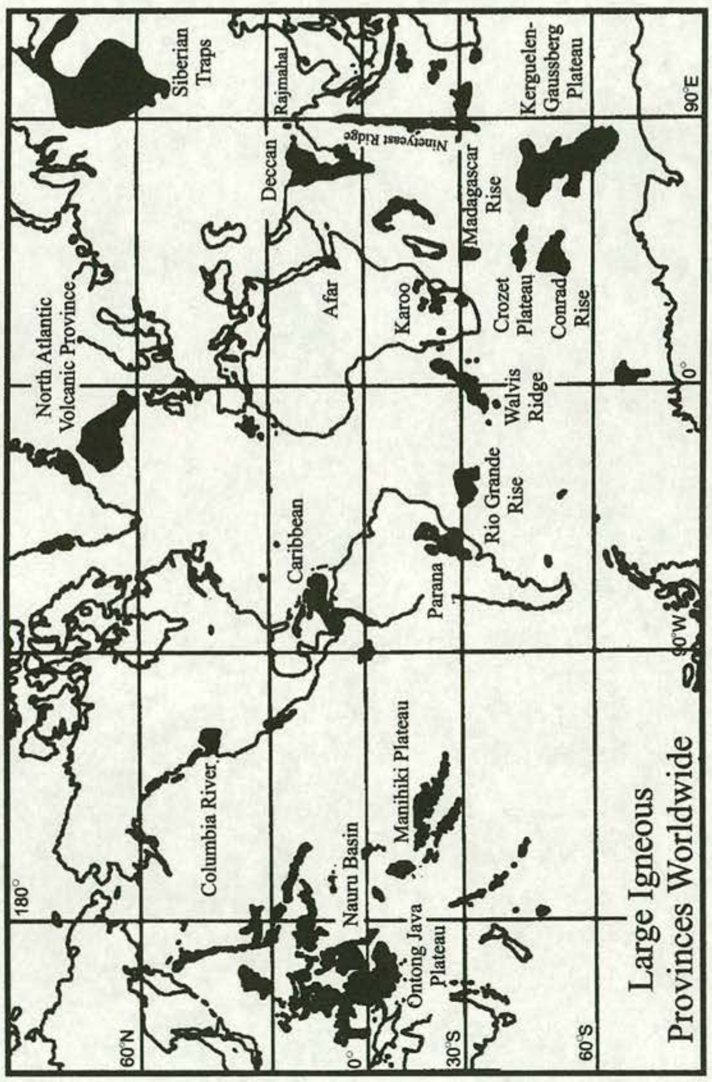


Figure 1.1. The location of large igneous provinces (LIPs), redrawn from Saunders *et al.* (1992).

Large Igneous Province	Location	Area (10^6 km^2)	Volume (10^6 km^3)	Notes	Age (Ma)
Ontong Java Plateau (OJP)	**Pacific**				117.7-118.2; 121-124
Ontong Java Plateau		1.86	49.0-61.3	crustal thickness from seismic refraction data.	
Ontong Java Plateau		1.86	8.4	extrusives	
Nauru Basin		1.75	0.856		
Manihiki Basin		0.77	8.8-13.6		
Pigafetta and E. Mariana basins		0.5	0.25		
TOTAL		**4.88**	**36.4-76.0**		
Kerguelen (K)	**Indian**				1.9.5-114
Kerguelen Plateau		1.54	9.9-15.4		
Kergulen Plateau		1.54	7.7	extrusives	
Elan Bank		0.24	1.2-1.9		
Broken Ridge		0.51	4.1-6.9		88.0-89.2
TOTAL		**2.3**	**15.2-24.1**		
North Atlantic (NAIP)	**Atlantic**				62-54.5
North Atlantic		>1.3	6.63		
North Atlantic		>1.3	1.8	extrusives	
TOTAL		**>1.3**	**1.8-6.63**		
Deccan (D)	**Indian**				64.5-65.5; 65-69
Deccan traps		0.1-1.5	8.2		
Deccan Traps		0.5-1.5	>1.5	extrusives	
Seychelles		0.25	?		
TOTAL		**0.75-1.75**	**8.2**		
Columbia River (CRB)					6-17.5; 15.7-17.2
Columbia River basalts		0.1637	1.3		
TOTAL		**0.1637**	**1.3**		

Table 1.1. A summary of the location, age and size of five large igneous provinces, taken from Coffin and Eldholm (1994).

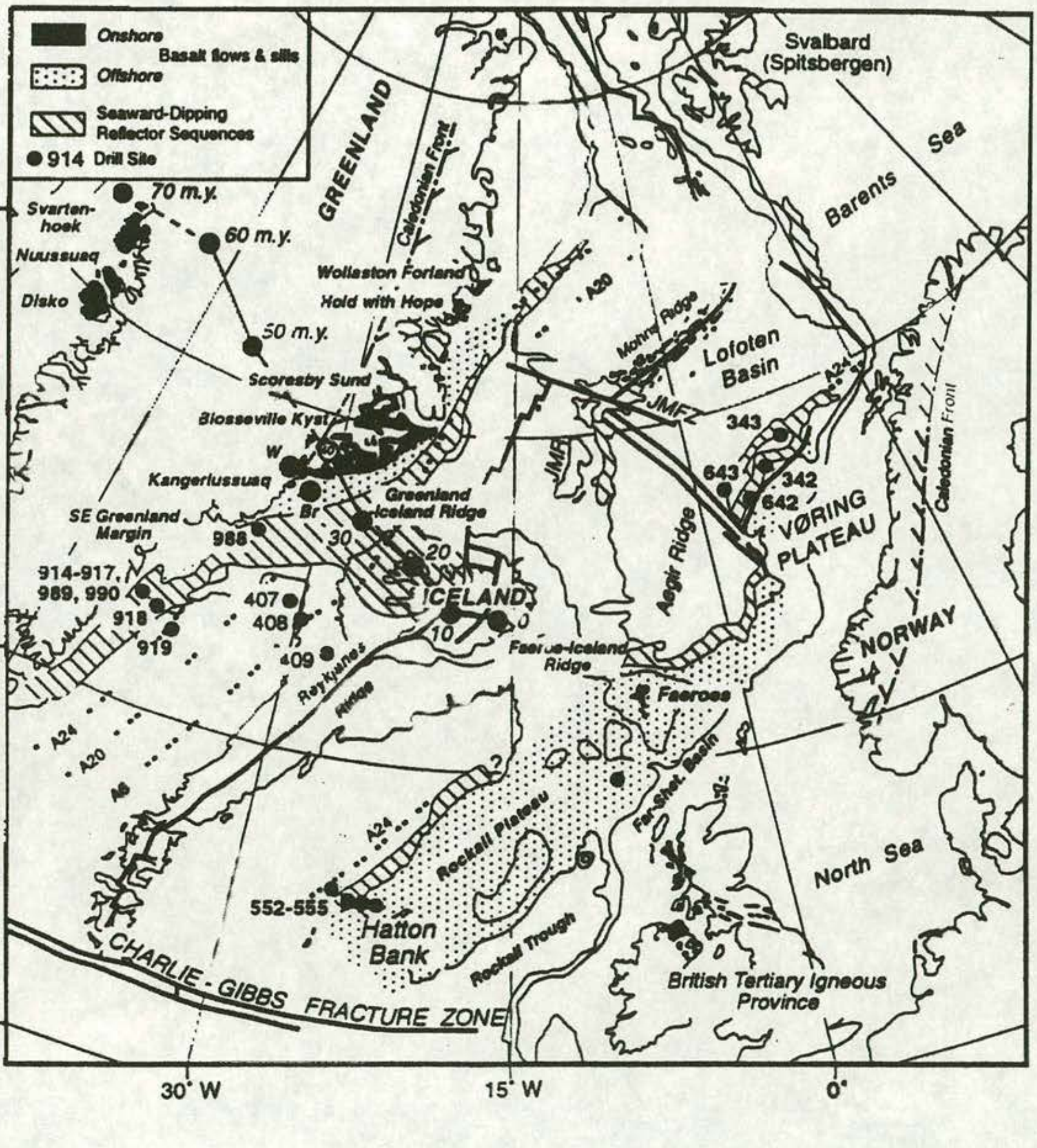


Figure 1.2. A location map of the North Atlantic Igneous Province taken from Fitton *et al.* (1997). The location of the proposed plume centre through time is shown, as are the location of DSDP and ODP drill sites.

North Atlantic Volcanic Province	
Length of plate boundary	2560 km
Area covered by extrusives (km^2)	1.3* 10^6
Volcanic margin volume (km^3)	
Extrusive basalt	1.8 *10^6
LCB	2 *10^6
Igneous crust	6.3 *10^6
East Greenland basalts (km^3)	0.23 *10^6
Total crustal volume (km^3)	6.6 *10^6

Table 1.2. Dimensions of the North Atlantic Igneous Province taken from Richards *et al.* (1989).

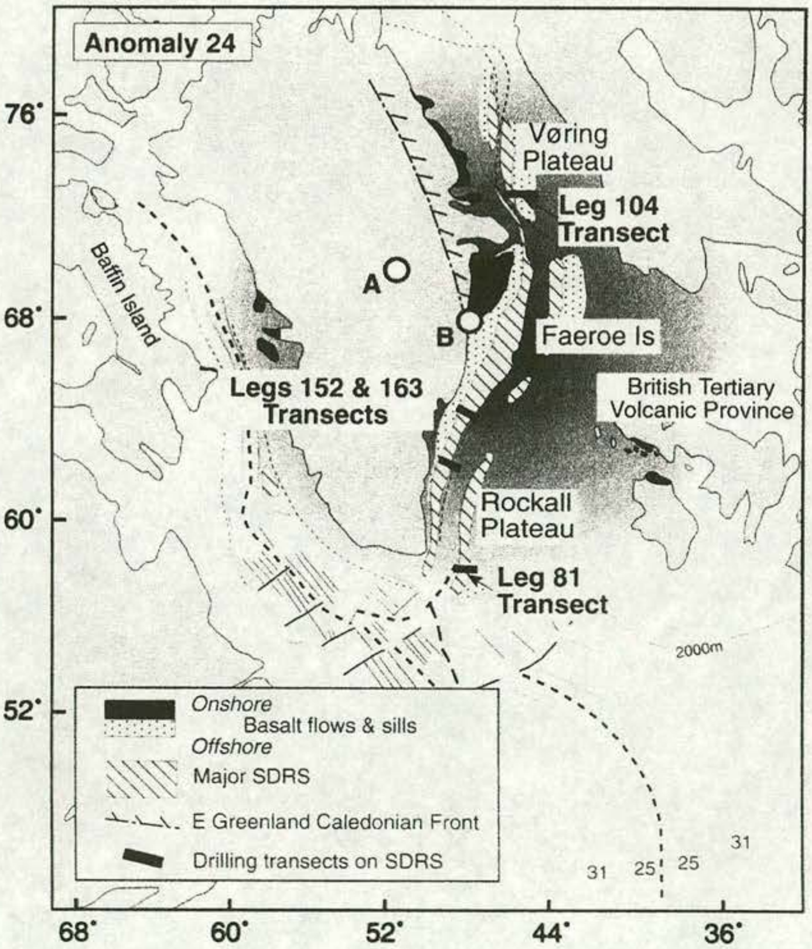


Figure 1.3. A palaeogeographic reconstruction of the North Atlantic at Anomaly 24 (Chron 24r from 55.904-53.347 Ma, Berggren *et al.*, 1995). DSDP and ODP sites are shown as are the proposed plume centre sites of (A) Lawver and Müller (1994) and (B) White & McKenzie (1989). The British Tertiary Province is located on the eastern margin of the proposed plume head. This reconstruction assumes that the plume is stationary.

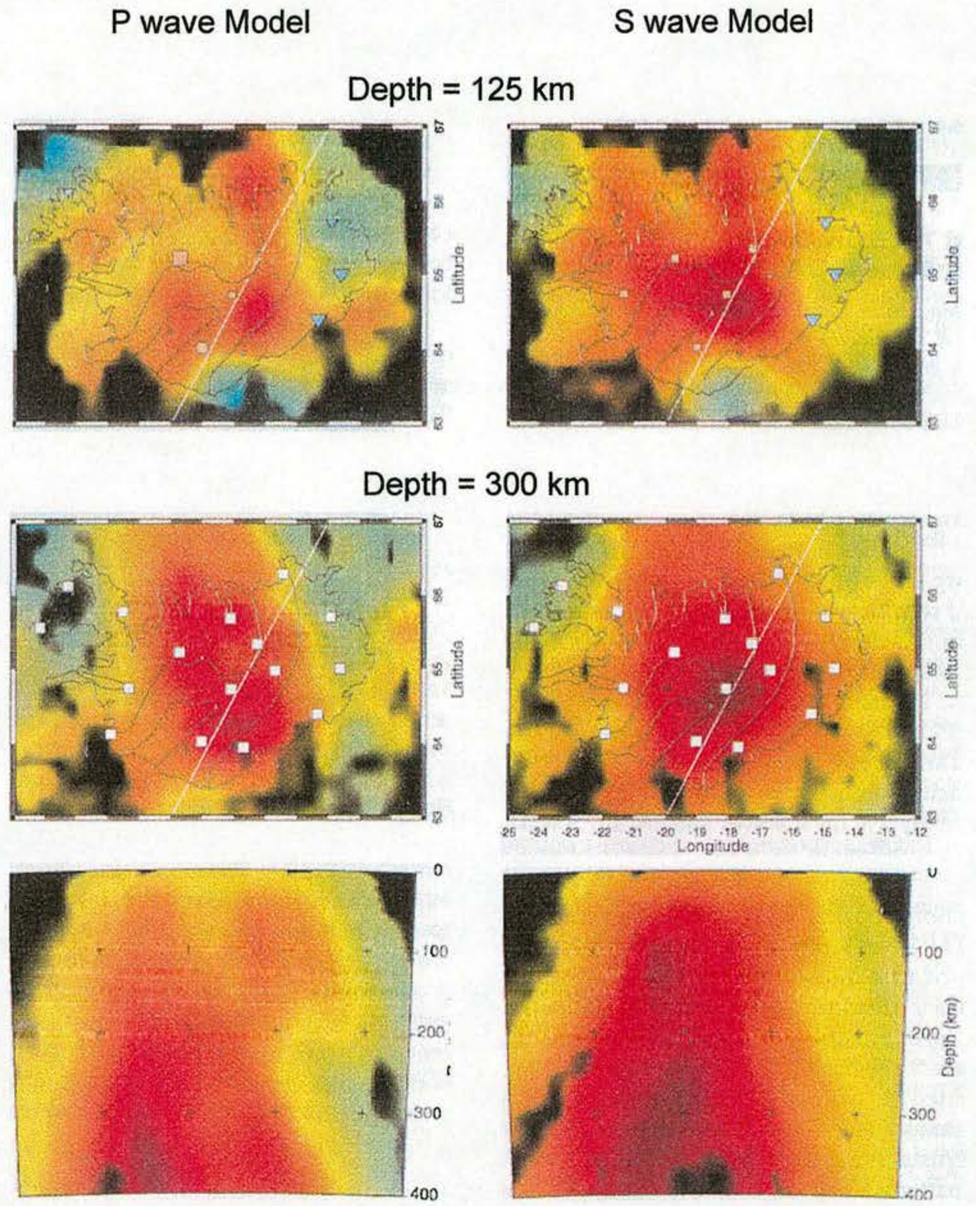


Figure 1.4. A seismic tomography image of the present-day Iceland hotspot from Wolfe *et al.* (1997). Both the P-wave model (left hand side) and the S-wave model (right hand side) are shown. Yellow-red colours indicate a low seismic velocity. The vertical cross sections (bottom row) are taken along the white lines shown. The top diagrams show areas of low seismic velocity that correspond to the neovolcanic zone at a depth of 125 km and the middle diagrams at a depth of 300km. The low velocity regions seen in cross section (bottom) appear to extend greater than 300 km in depth, but can only be resolved to 400 km.

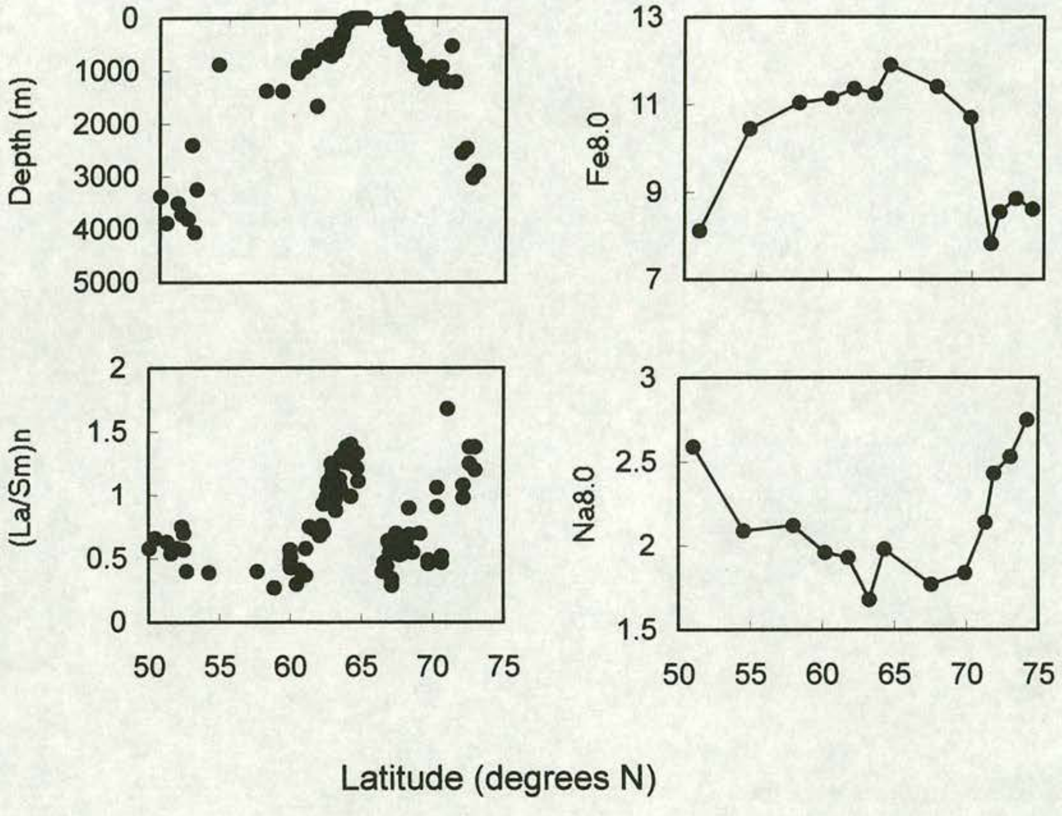


Figure 1.5. Major element and trace element variations to the north and south of Iceland (J. G. Fitton, unpublished data). Water depth and major element compositions of basalt illustrate the extent of the thermal anomaly around Iceland (Fitton *et al.*, 1997). Na and Fe have been normalised to 8 wt% MgO values. La/Sm is used suggest the extent of the chemical anomaly away from Iceland. Plume components have high La/Sm ratios and ambient upper mantle low ratios.

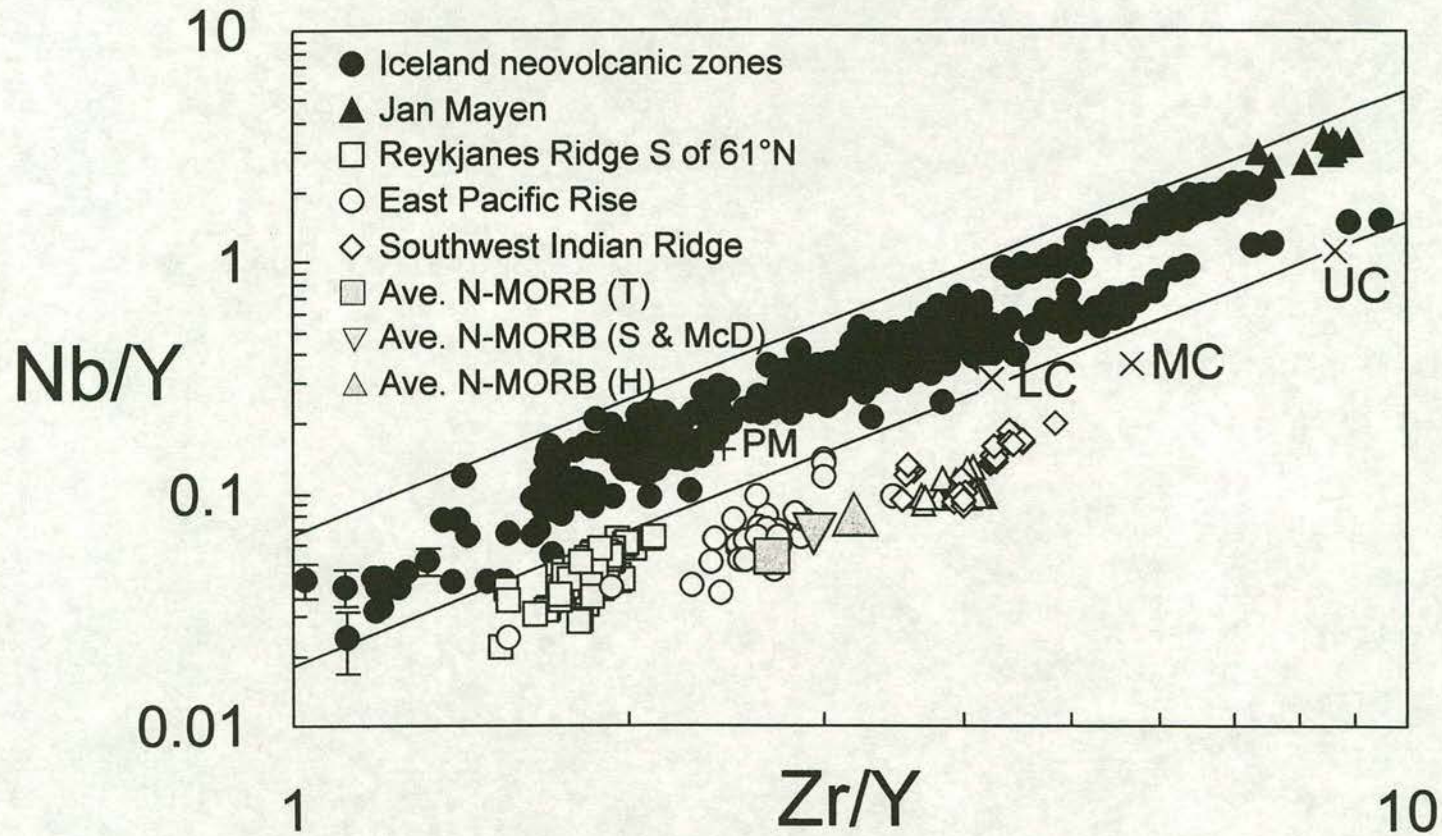


Figure 1.6. The Zr-Y-Nb discrimination diagram of Fitton *et al.* (1997). The two parallel lines enclose analyses of rocks from Iceland, which are used to define the Iceland array. Normal mid-ocean ridge basalt (N-MORB) plots below the lower line. This is true of MORB from different areas as shown. Average values of N-MORB (Hofmann, 1988; Sun and McDonough, 1989), as are average values of the lower, middle and upper crust (Rudnick and Fountain, 1985). PM = Primitive mantle (McDonough and Sun, 1995). ΔNb is defined as distance in log units from the lower boundary line.

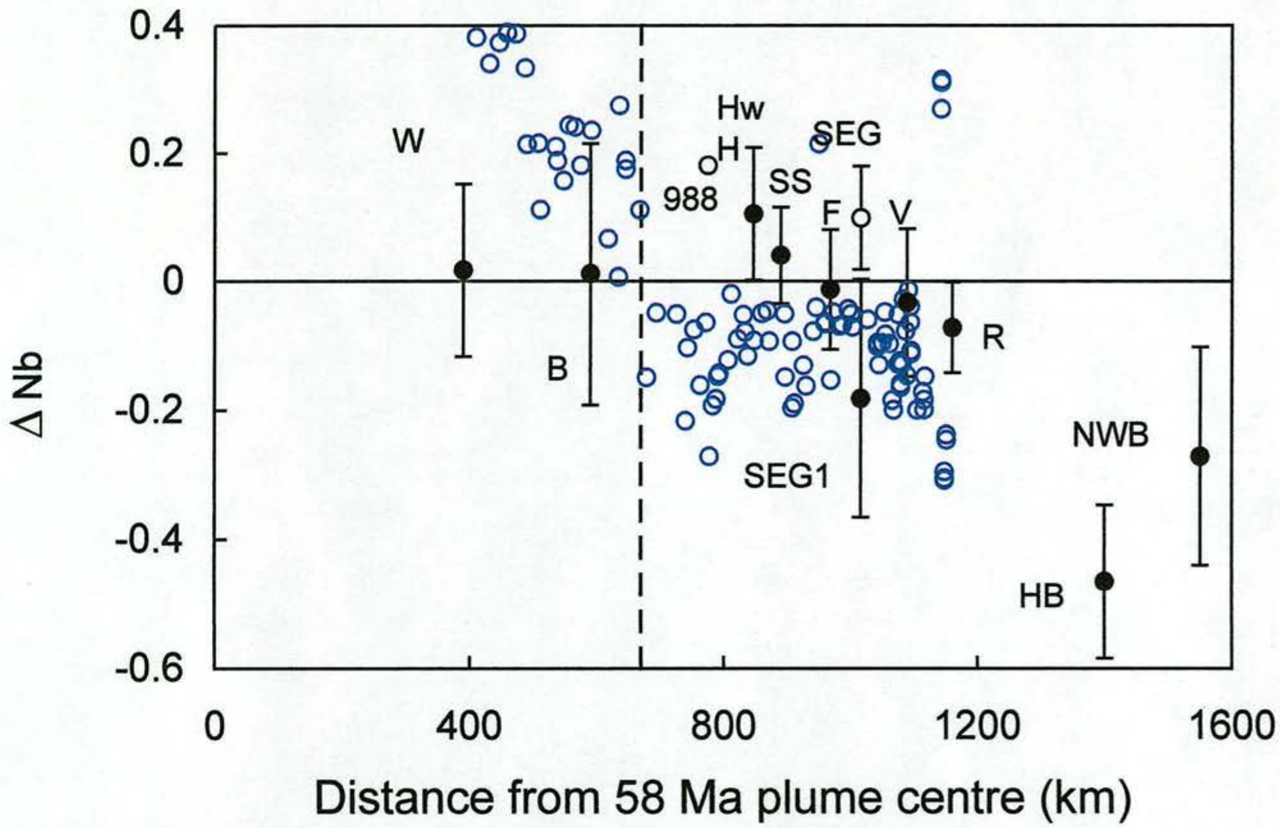


Figure 1.7. Variation in ΔNb with distance from the proposed plume centre at 58 Ma (Lawver and Müller, 1994) taken from Fitton *et al.* (1997). The samples are separated into the two phases of Saunders *et al.* (1997); Phase 1 (62-58 Ma) with solid symbols and Phase 2 (after 56 Ma) with open symbols. The margins of the plume during both phases has negative ΔNb, while the core has positive ΔNb. Reykjanes Ridge data, plotted as blue circles, shows that this zoning of the plume is seen today.

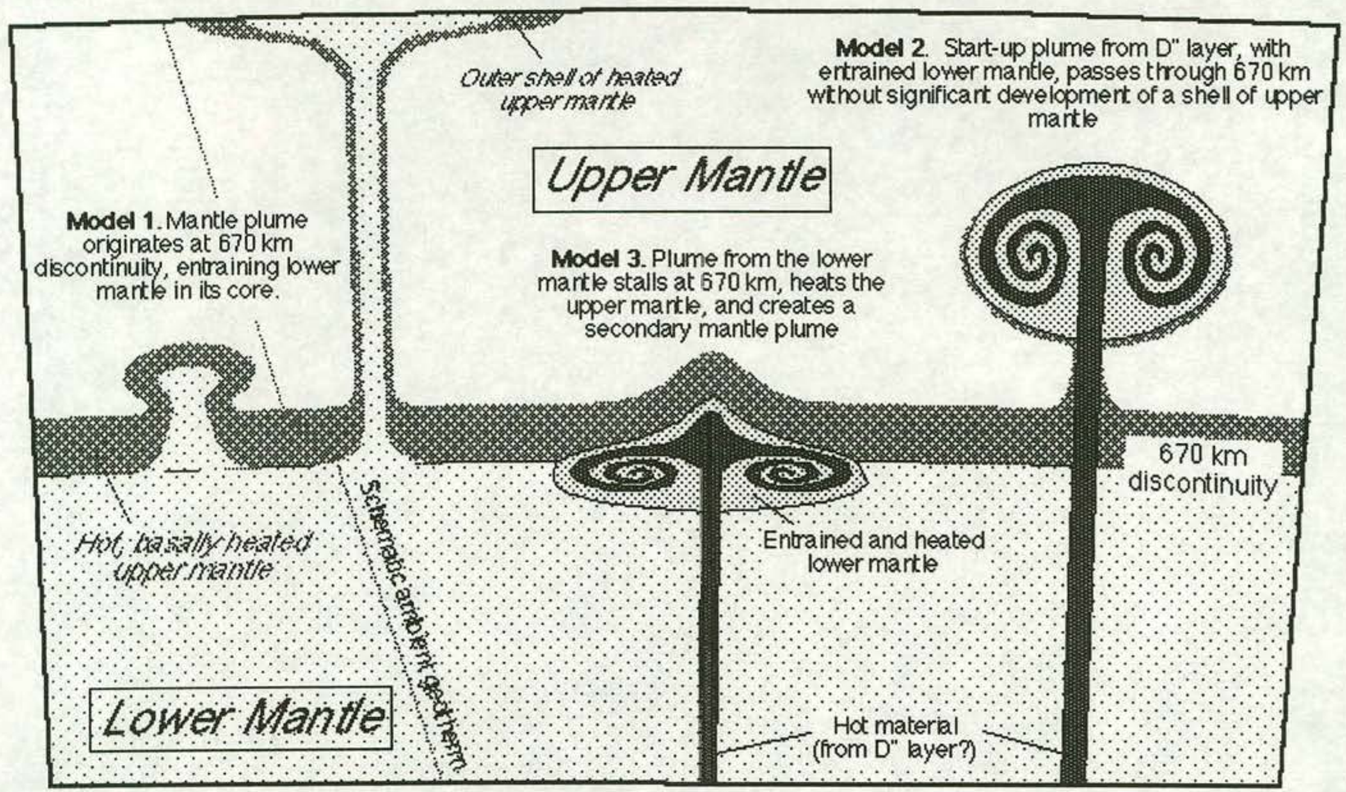


Figure 1.8. A schematic diagram showing different models for plumes generated at thermal boundary layers within the mantle, taken from Fitton *et al.* (1997). A plume originating at the core-mantle boundary will take much more of its volume from the lower mantle (Model 2) unlike a plume originating at the 670 km discontinuity (Model 1). A plume from the core-mantle boundary could stall at 670 km and trigger a plume from this thermal layer (Model 3). The thickness of the outer zone of heated upper mantle is a key difference between Models 1 and 2.

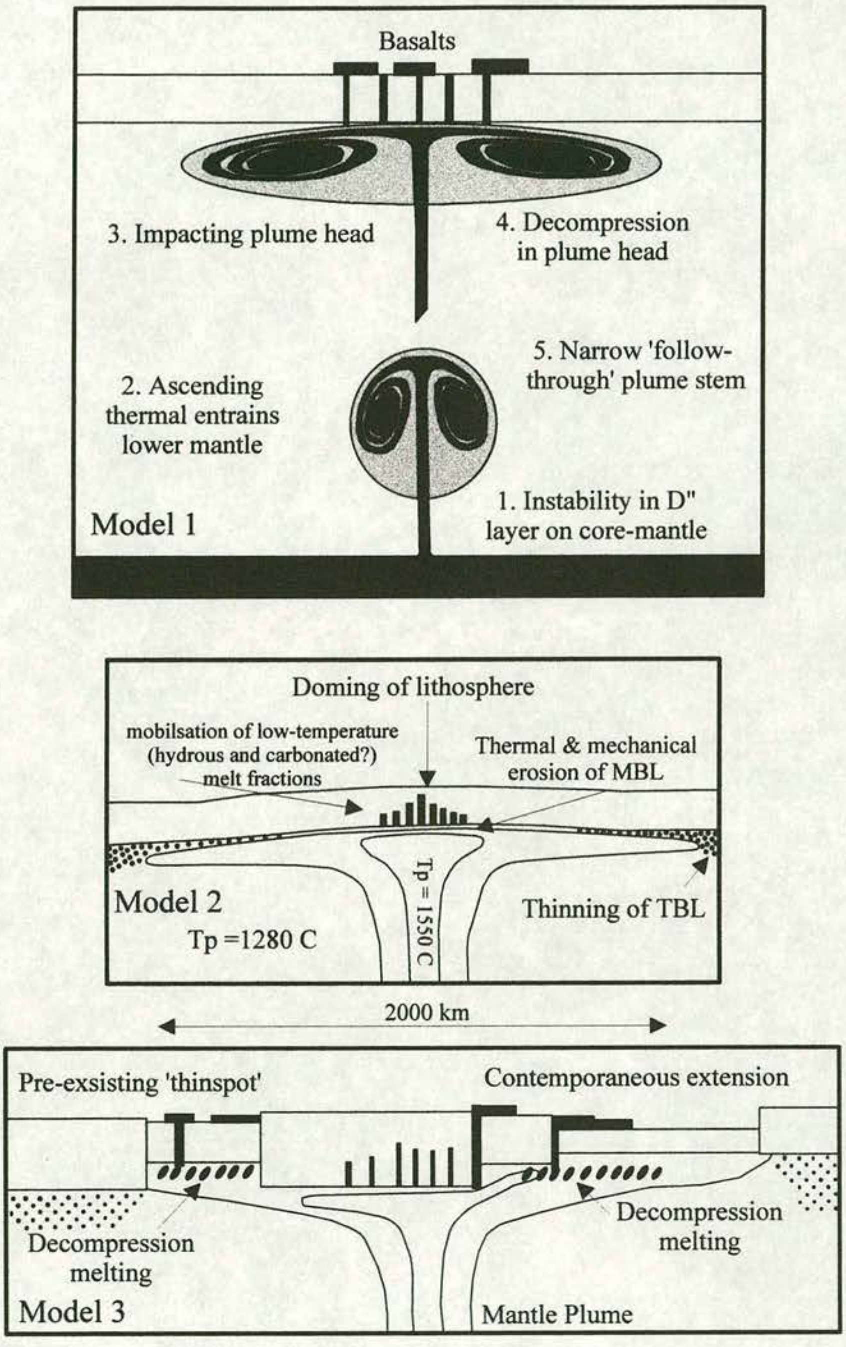


Figure 2.1. A schematic diagram of the three plume models, redrawn from Saunders *et al.* (1992). Model 1 shows the large impacting plume head which triggers rifting and volcanism. Model 2 shows a steady state plume beneath the lithosphere, which slowly builds up heat causing softening of the lithosphere. Magmatism in this type of plume model will only occur once rifting has begun. Model 3 builds on either Model 1 or 2, but the plume is directed towards thinspots in the lithosphere where decompressional melting can occur.

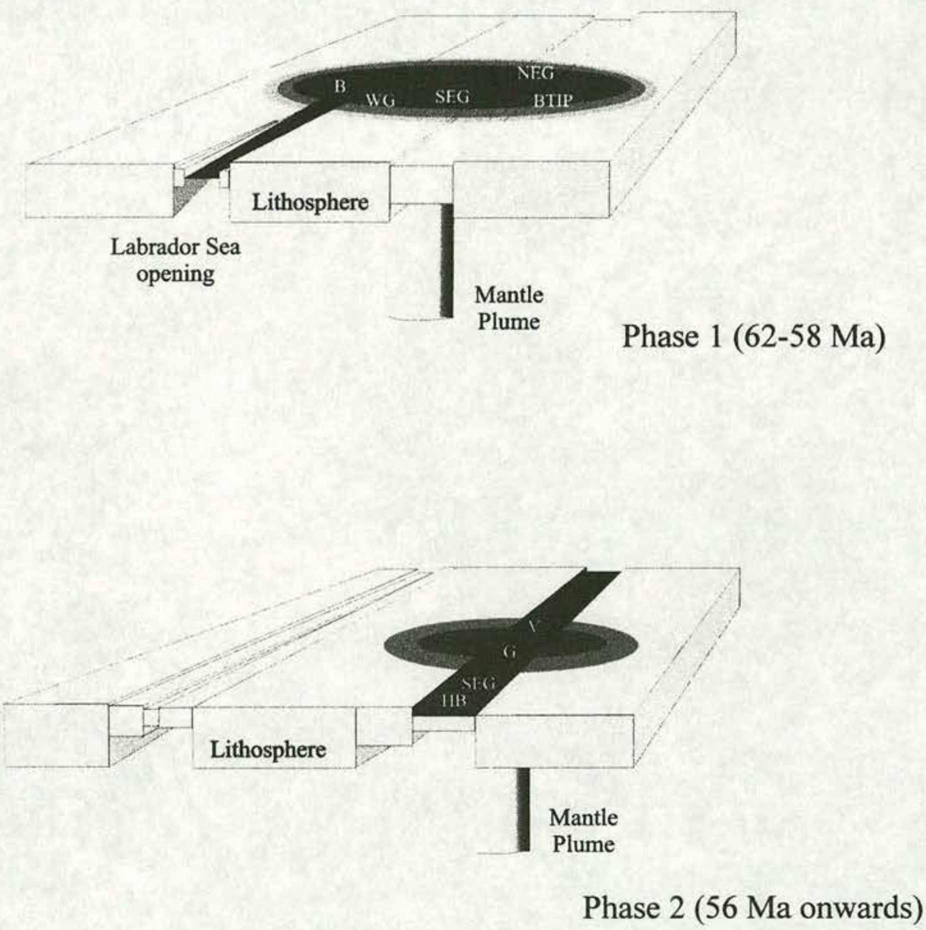


Figure 2.2. Magmatism in the North Atlantic Igneous Province has been divided into two phases (Saunders *et al.*, 1997). Magmatism of Phase 1 occurs prior to rifting, while the magmatism of Phase 2 is concentrated along the active rift zone after 56 Ma. B = Baffin Island; WG = West Greenland; SEG = Southeast Greenland; BTIP = British Tertiary Igneous Province; NEG = Northeast Greenland; V = Vøring Margin; HB = Hatton Bank; G = Greenland.

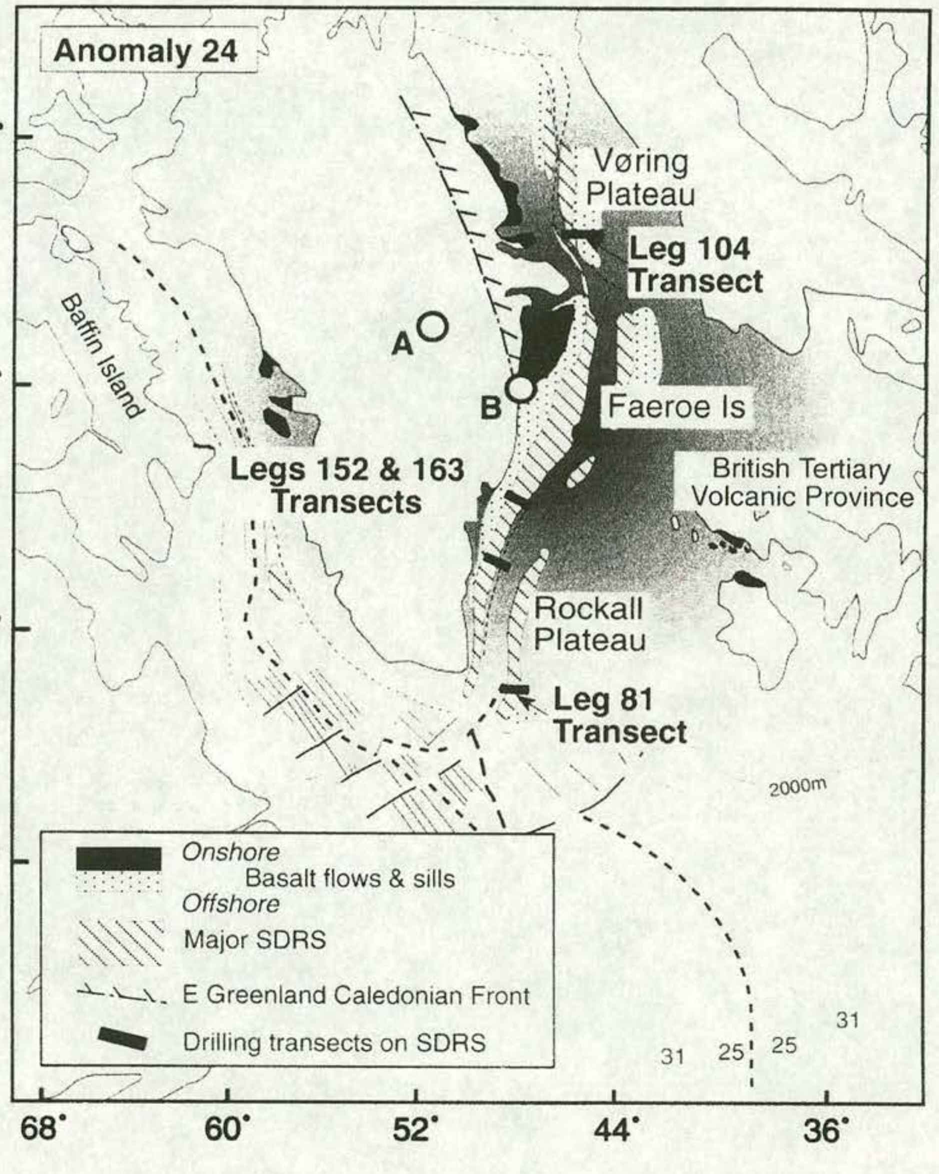


Figure 2.3. A palaeogeographic reconstruction to Anomaly 24. The plume head covers a pre-drift distance of 2000 km, as shown by the location of magmatism in Baffin Island and the British Tertiary Province. The sites of the plume centres are also shown; (A) Lawver and Müller (1994); and (B) White and McKenzie (1989).

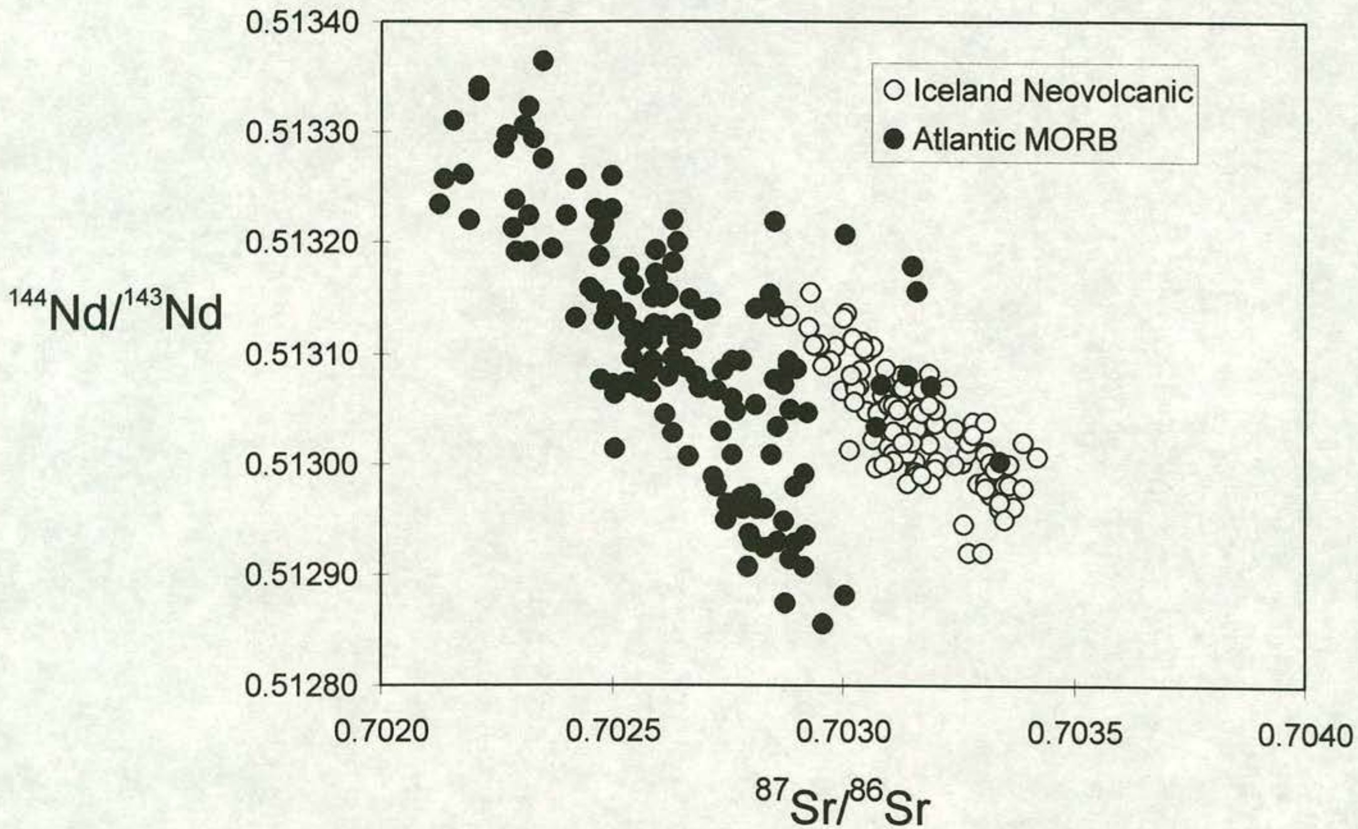


Figure 2.4. $^{87}Sr/^{86}Sr$ versus $^{144}Nd/^{143}Nd$ for North Atlantic mid-ocean ridge basalt (MORB) and the Iceland neovolcanic zone. MORB data is from Taylor *et al.* (1997) and Iceland from Hardarson *et al.* (1997). MORB and Iceland samples form two overlapping arrays, the bulk of Atlantic MORB samples form a parallel array to Iceland.

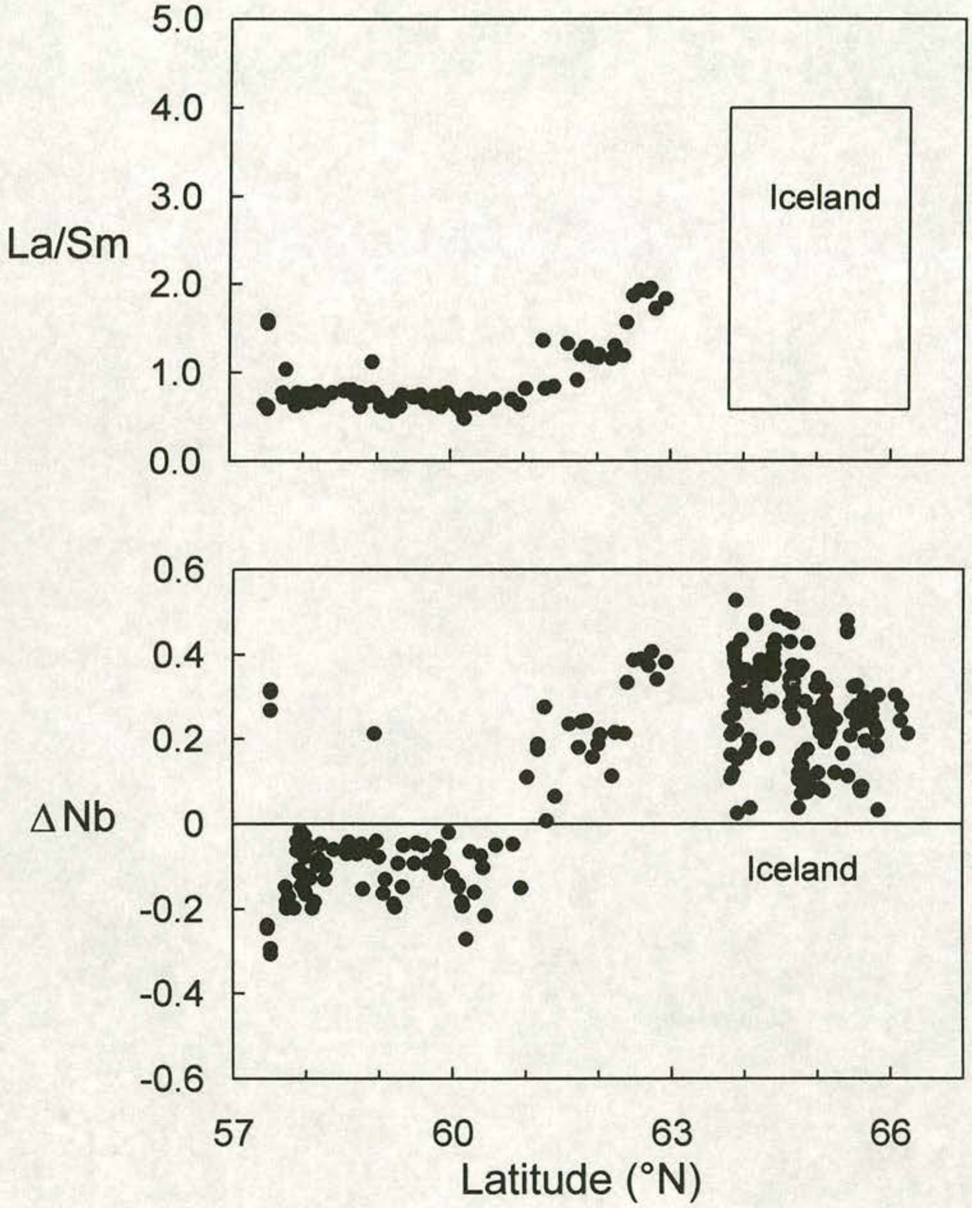


Figure 2.5. Variations in La/Sm and ΔNb down the Reykjanes Ridge, taken from Fitton *et al.* (1997). The total range in La/Sm ratios down the Reykjanes Ridge can also be found in Iceland. In contrast, ΔNb changes sharply at 61°N from positive to negative. The two anomalous positive ΔNb values after this point are from a seamount and a section of ridge that is otherwise normal.

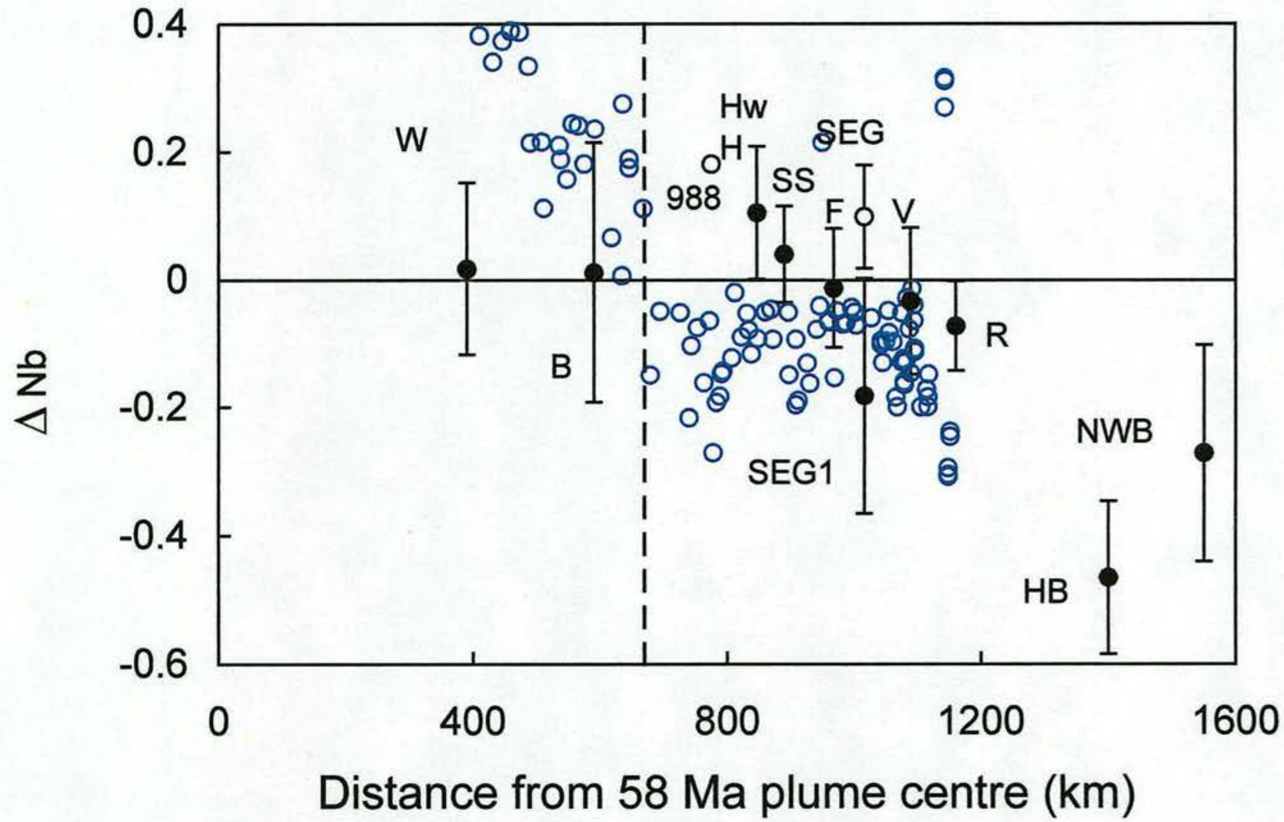


Figure 2.6. Variation in ΔNb with distance from the proposed plume centre of Lawver and Müller (1994), taken from Fitton *et al.* (1997). The samples are subdivided using the two phase scheme of Saunders *et al.* (1997). The plume can be seen to be chemically zoned throughout its history, with a core of 'Icelandic' mantle surrounded by hot upper mantle. Reykjanes Ridge data (blue circles) illustrates the present zoning of the plume.

Ma	Event
75	Initiation of regional uplift/ nondeposition and extensional faulting. Plume head at 650-780 km. No decompressional melting.
75-57	Additional central rift uplift, erosion and redeposition. Plumehead is approaching the base of the lithosphere.
63-62	End of regional depositional hiatus. Plumehead collapses as it impinges on the base of the lithosphere. First igneous activity in the realm of the Iceland plume.
59-58	Magmatism over the >300km wide rift zone where P-T conditions are good for melting. Melt emplacement at crustal levels as dacitic lavas extruding near the incipient plate boundary (ODP site 642), sills are intruding regionally in the adjacent basins.
57.5	Continental break-up, massive extrusive volcanism centred along the new plate boundary. Regional igneous activity ceases.
57-54	End of transient extrusive phase
54-0	Thermal subsidence of the continental margin.

Table 2.1. Geological development of the Vøring Margin, summarised from Skogseid *et al.* (1992).

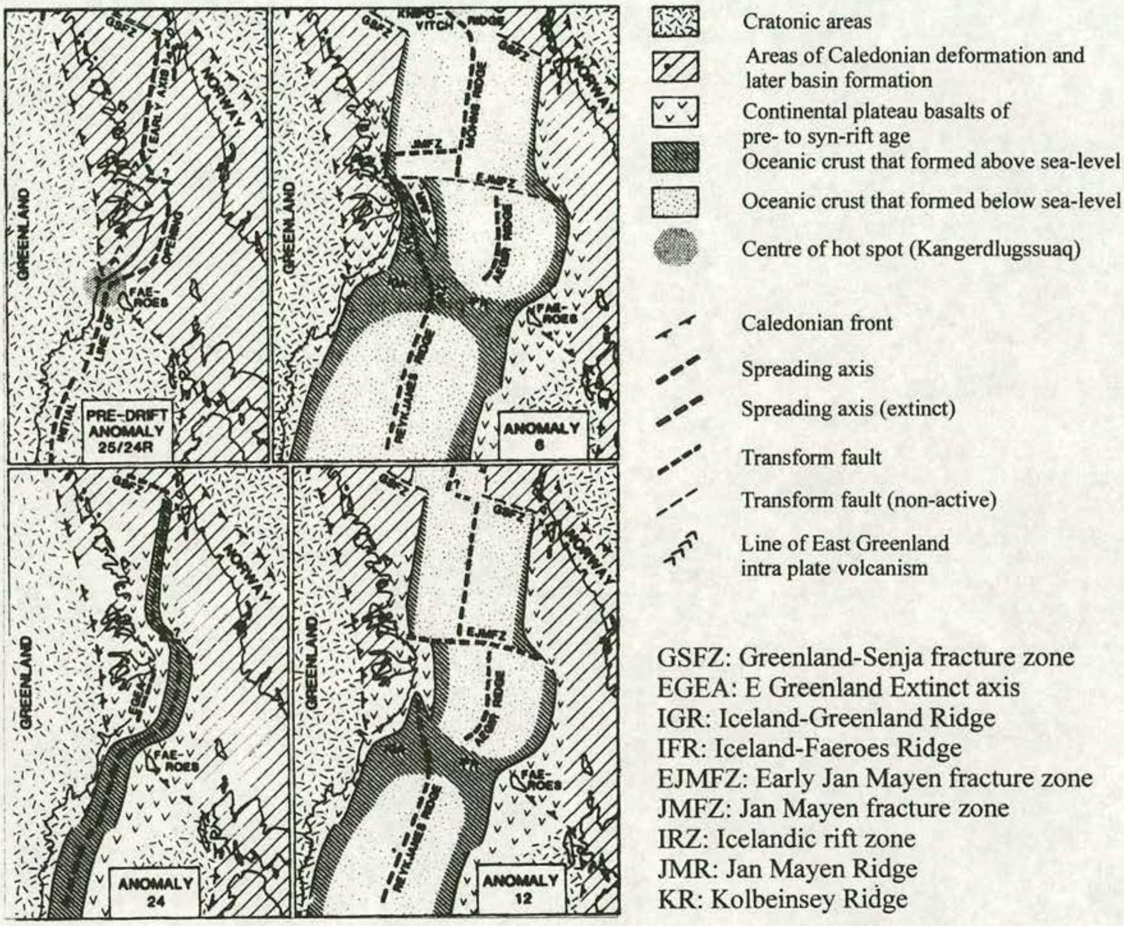


Figure 2.7. Summary diagrams showing the development of the rift system in the North Atlantic, redrawn from Larsen (1988).

Area	Rock	Location	Age	Error	Method	Reference
East Greenland	dolerite dyke	Imilik Intrusion II	56.2	0.6	Ar-Ar	Tegner *et al*, 1998
	wehrlite sill	Imilik Intrusion III	49.2	0.2	Ar-Ar	Tegner *et al*, 1998
	wehrlite sill	Imilik Intrusion III	52.1	0.6	Ar-Ar	Tegner *et al*, 1998
	gabbro	Kruuse Fjord	51.5	0.3	Ar-Ar	Tegner *et al*, 1998
	gabbro	Igtutarajik	47	0.2	Ar-Ar	Tegner *et al*, 1998
	wehrlite sill	Kap E. Holm	47.3	0.3	Ar-Ar	Tegner *et al*, 1998
	gabbro	Kap E. Holm	48.8	0.2	Ar-Ar	Tegner *et al*, 1998
	syenite	Lilloise	50	0.4	Ar-Ar	Tegner *et al*, 1998
	diabase sill	I. C. Jacobsen fjord	56.3	0.9	Ar-Ar	Tegner *et al*, 1998
	diabase sill	Fairy Tale valley	56	0.4	Ar-Ar	Tegner *et al*, 1998
West Greenland	lavas	Vaigat Fm	60.4	0.5	Ar-Ar	Storey *et al*, 1998
	lavas	Vaigat Fm	60.3	1	Ar-Ar	Storey *et al*, 1998
	lavas	Vaigat Fm	60.7	0.5	Ar-Ar	Storey *et al*, 1998
	lavas	Maligat Fm	60.5	0.4	Ar-Ar	Storey *et al*, 1998
	lavas	Maligat Fm	60.3	0.4	Ar-Ar	Storey *et al*, 1998
	lavas	Maligat Fm	59.4	0.5	Ar-Ar	Storey *et al*, 1998
	dykes and sills	Tartunaq dykes and sills	54.8	0.4	Ar-Ar	Storey *et al*, 1998
	dykes	West Disko dykes	53.6	0.3	Ar-Ar	Storey *et al*, 1998
	tuff	Comendite tuff	52.5	0.2	Ar-Ar	Storey *et al*, 1998
Darwin Complex	dacite	163/6-1A	55.3	0.3	Ar-Ar	Sinton *et al*, 1999
Hebrides Shelf	basalt	85/5B	55.8	0.7	Ar-Ar	Sinton *et al*, 1999
Voring Margin	tuff glass	ODP 104-642E	55.6	0.8	Ar-Ar	Sinton *et al*, 1999
Voring Margin	tuff glass	ODP 104-642E	53.7	0.5	Ar-Ar	Sinton *et al*, 1999
Voring Margin	feldspar	ODP 104-642E	57.3	1	Ar-Ar	Sinton *et al*, 1999
Voring Margin	feldspar	ODP 104-642E	55.8	0.7	Ar-Ar	Sinton *et al*, 1999
SE Greenland	dacite	ODP 152-917A	61.4	0.6	Ar-Ar	Sinton *et al*, 1999
Muck	sanidine	Nr base of lavas	62.8	0.6	Ar-Ar	Pearson *et al*, 1996
	sanidine	Nr base of lavas	62.4	0.6	Ar-Ar	Pearson *et al*, 1996
Eigg	pitchstone	An Sgurr	52.1	0.5	Rb-Sr	Dickin and Jones, 1983
Rum	granophyre	Western Rum	59.8	0.4	Ar-Ar	Mussett, 1984
	lava		61.4	0.4	Ar-Ar	Mussett, 1984
	peridotite	layered complex	60.53	0.08	U/Pb	Hamilton et al ,1998
Ardnamurchan		C3	60	1.7	Rb-Sr	Mussett *et al*, 1988
		C3	60.5	2	K-Ar	Mitchell and Reen, 1972
Mull	felsite	Loch Ba	56.5	1	Ar-Ar	Mussett, 1986
	lavas		60	0.5	Ar-Ar	Mussett, 1986
Skye	whole/fspar	Beinn an Dubhaich epigranite	53.5	0.4	Rb-Sr	Dickin, 1981
	gabbro	Cuillins	58.91	0.07	U/Pb	Hamilton *et al*,1998
	sill		54.9	0.6	Ar-Ar	Mussett *et al*, 1988
	granite	Loch Ainhort Granite	58.7	0.9	Rb-Sr	Dickin, 1981
	feldspar	Coire Uaigneich granite	59.3	0.7	Rb-Sr	Dickin, 1981
Arran	qtz porph	dykes	58.5	0.8	Ar-Ar	Mussett *et al*, 1987
	granite	northern	60.3	0.8	Rb-Sr	Dickin *et al*, 1981
	granite	northern	60.3	0.6	Ar-Ar	Evans *et al*, 1973
Antrim	granite	Mourne G1	56.2	0.7	Ar-Ar	Gibson *et al*,1995
	granite	Mourne G2	54.9	1.2	Ar-Ar	Thompson et al , 1987
	granite	Mourne G3	56.4	0.1	Ar-Ar	Gibson *et al*,1995
	granite	Mourne G4	56	0.4	Ar-Ar	Gibson *et al*,1995
	granite	Mourne G4	54.5	0.8	Ar-Ar	Thompson *et al*, 1987

Table 2.2. Some of the available age dates for samples from the North Atlantic Igneous Province.

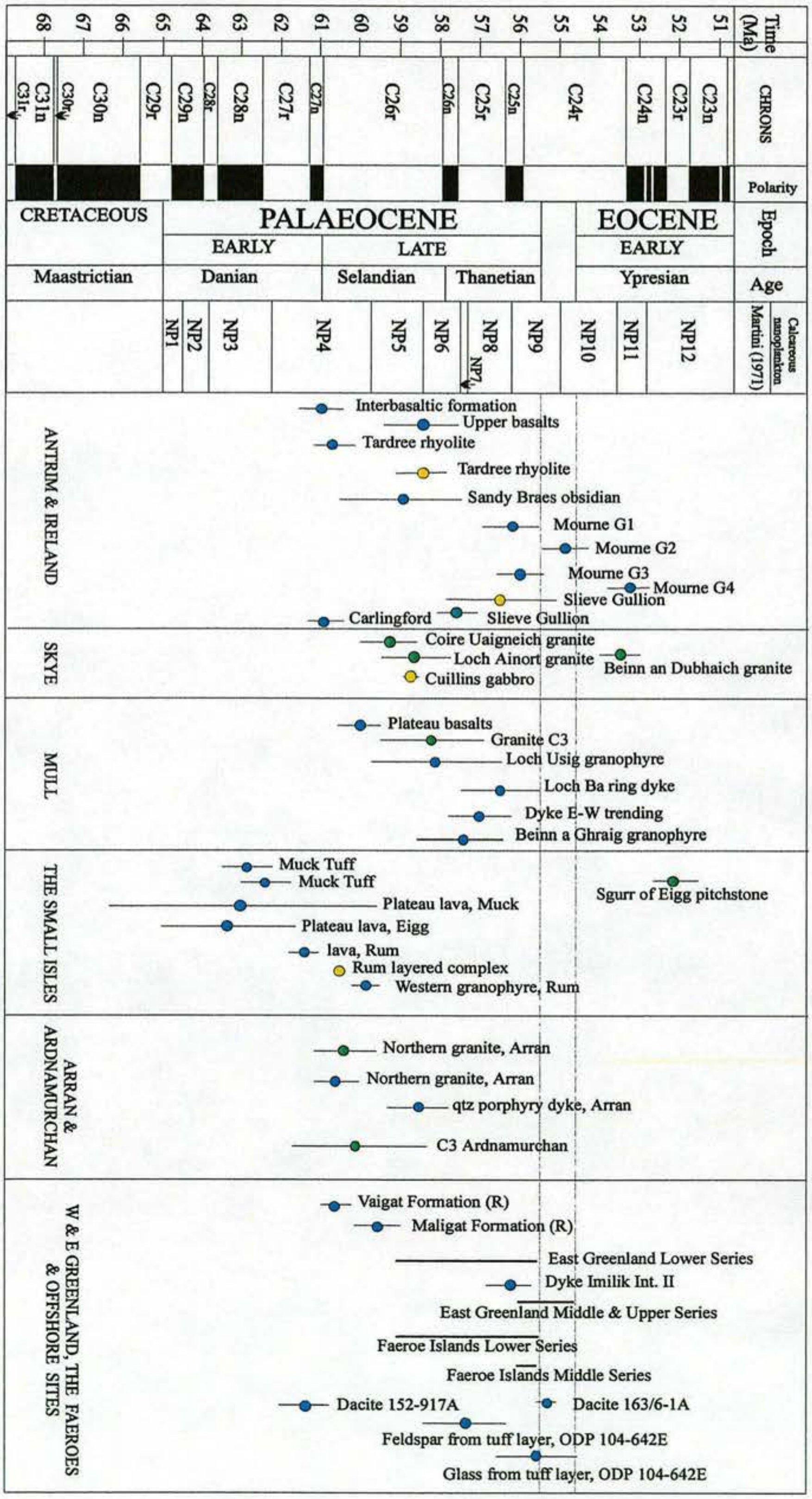


Figure 2.8. Age dates summarised in Table 2.2 plotted onto the time scale of Berggren *et al.* (1995). Light blue = $^{40}Ar/^{39}Ar$ age; green = Rb-Sr age; yellow = U/Pb age.

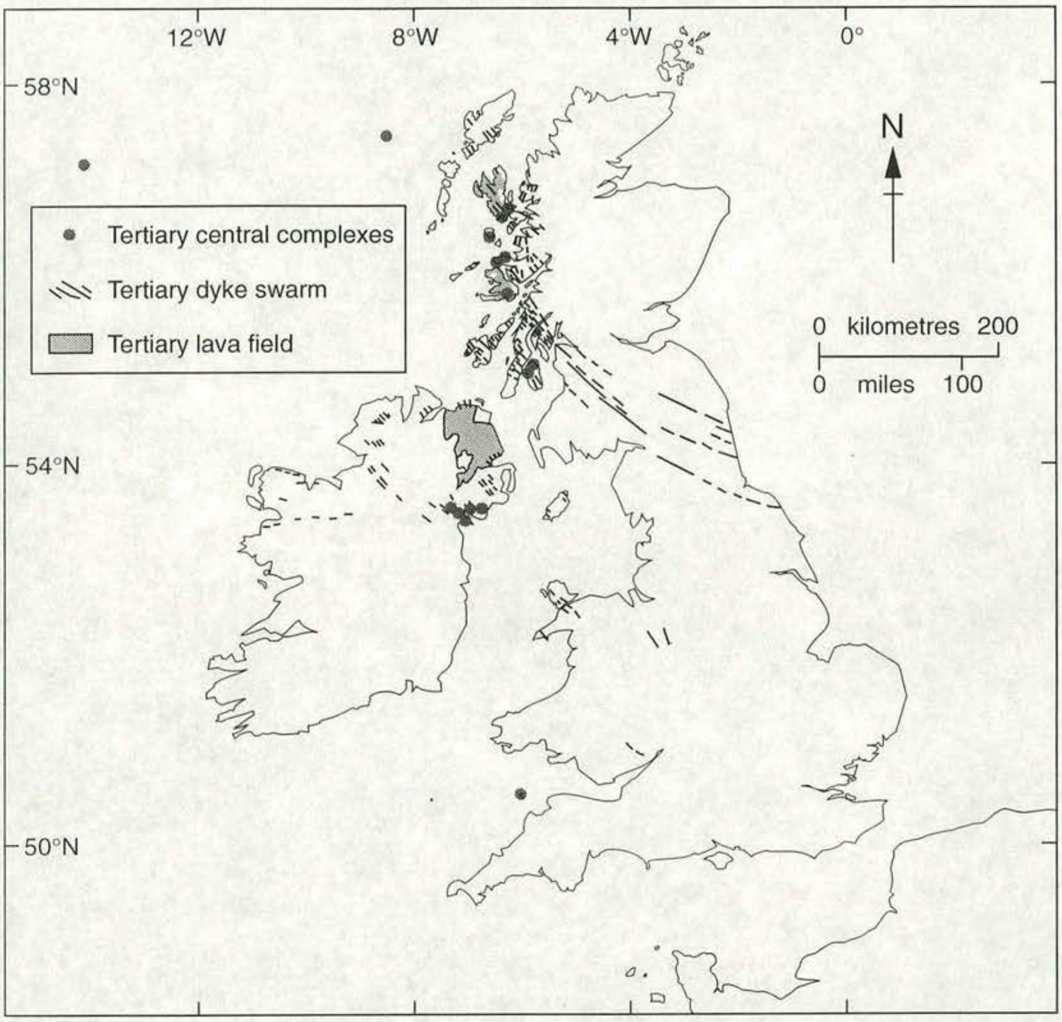


Figure 2.9. A location map of the British Tertiary Igneous Province showing the plateau lava fields and the central complexes. The regional dyke swarm can be seen crossing a much wider area than the Tertiary centres.

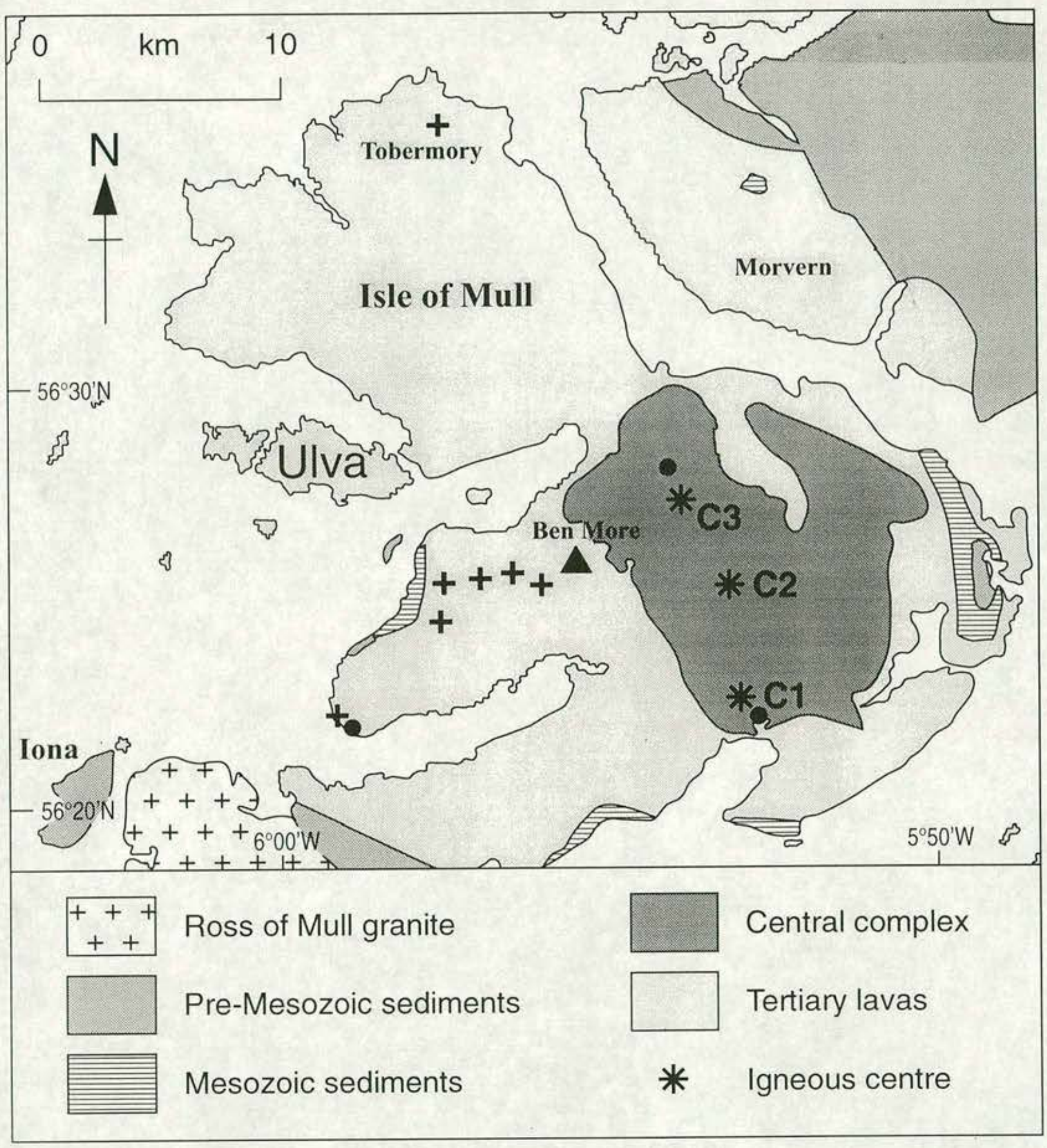


Figure 2.10. A simplified geological map of the Isle of Mull showing the focus of igneous activity moving north westwards with time (C1-C3).

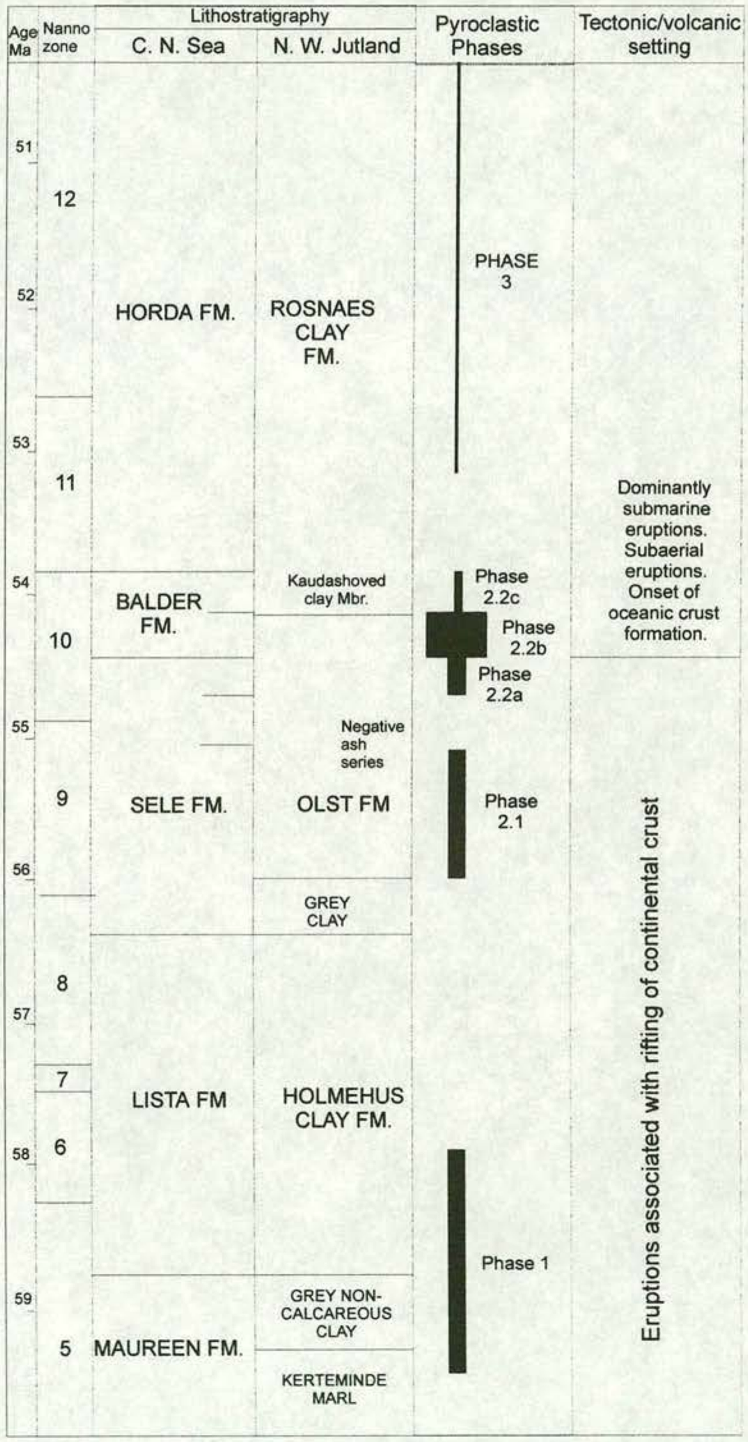


Figure 2.11. Chronology and correlation of ash layers in Denmark and the North Sea, taken from Knox (1997). Pyroclastic events are divided into two main phases.

Location	Rock type	Details	Age	Error	Type	Reference
Muck	lavas	basal	63.00	3.40	Ar-Ar	Dagley and Mussett, 1986
	sanidine	Nr base of lavas	62.80	0.60	Ar-Ar	Pearson *et al*, 1996
	sanidine	Nr base of lavas	62.40	0.60	Ar-Ar	Pearson *et al*, 1996
Eigg	pitchstone	An Sgurr	52.10	0.50	Rb-Sr	Dickin and Jones, 1983
	lava	base lavas Eigg	63.30	1.80	Ar-Ar	Dagley and Mussett, 1986
Rum	granophyre	Western Rhum	59.80	0.40	Ar-Ar	Mussett, 1984
	lava		61.40	0.40	Ar-Ar	Mussett, 1984
	peridotite	layered complex	60.53	0.08	U/Pb	Hamilton *et al*,1998
Ardnamurchan		C3	60.00	1.70	Rb-Sr	Beckinsdale and Walsh
		C3	60.50	2.00	K-Ar	Michell and Reen, 1972
Mull	felsite	Loch Ba	56.50	1.00	Ar-Ar	Mussett, 1986
	granite C3		58.20	1.30	Rb-Sr	Walsh *et al,* 1979
	lavas		60.00	0.50	Ar-Ar	Mussett, 1986
Skye	whole/fspar	Beinn an Dubhaich	53.50	0.40	Rb-Sr	Dickin, 1981
	gabbro	Cuillins	58.91	0.07	U/Pb	Hamilton *et al*, 1998
	sill		54.90	0.60	Ar-Ar	Mussett *et al,* 1988
	granite	Loch Ainhort Granite	58.70	0.90	Rb-Sr	Dickin, 1981
	feldspar	Coire Uaigneich granite	59.30	0.70	Rb-Sr	Dickin, 1981
Arran	qtz porph	dykes	58.50	0.80	Ar-Ar	Mussett *et al,* 1987
	granite	northern	60.30	0.80	Rb-Sr	Dickin *et al,* 1981
	granite	northern	60.30	0.60	Ar-Ar	Evans *et al*, 1973
Antrim	gabbro	early	58.70	1.20	Ar-Ar	Thompson, 1986
	Granite	Mourne G1	56.20	0.70	Ar-Ar	Gibson *et al*,1995
	Granite	Mourne G2	58.10	1.60	Ar-Ar	Evans *et al*, 1973
	Granite	Mourne G2	54.90	1.20	Ar-Ar	Thompson *et al*, 1987
	Granite	Mourne G3	56.40	0.10	Ar-Ar	Gibson *et al*,1995
	Granite	Mourne G4	56.00	0.40	Ar-Ar	Gibson *et al*, 1995
	Granite	Mourne G4	54.50	0.80	Ar-Ar	Thompson *et al,* 1987
	Granite	Mourne G5	58.00	1.60	Ar-Ar	Evans *et al*, 1973
	Granite	Mourne G5	54.60	1.00	Ar-Ar	Gibson *et al*, 1995
		dyke cutting Mourne G5	53.10	1.00	Ar-Ar	Thompson *et al*, 1987
	Granophyre	Carlingford	60.90	0.50	Ar-Ar	Thompson, 1986
	Rhyolite	Tardree	60.70	0.60	Ar-Ar	In Meighan *et al*, 1988
	Granite	Mourne G1	56.40	1.40	U/Pb	Gamble *et al*, 1999
	Granite	Mourne G2	55.30	0.80	U/Pb	Gamble *et al*, 1999
	Granite	Slieve Gullion	56.50	1.30	U/Pb	Gamble *et al*, 1999
	Obsidian	Tardree	58.40	0.70	U/Pb	Gamble *et al,* 1999
	Obsidian	Sandy Braes	59.00		Ar-Ar	Thompson *et al,* 1984
	dyke	Blind rock	61.70	0.50	Ar-Ar	Thompson, 1986
	Rhyolite	Tardree	64.60	5.00	fisson	Fitch and Hurford, 1977
	Rhyolite	Tardree	65.50	3.60	fisson	Fitch and Hurford, 1977
Blackstones	basalts	8 samples	58.60	0.90	K-Ar	Mitchell *et al,* 1976
Helen's reef	microgabbro	3km east Rockall	79.00	3.00	K-Ar	Harrison *et al*, 1975
	microgabbro	3km east Rockall	114.00	3.00	K-Ar	Harrison *et al,* 1975
Lundy	granite		54.80	1.40	Ar-Ar	Fitch *et al,* 1969
		dykes	56.40	0.30	Ar-Ar	Mussett *et al,* 1988
	granite		57.00	2.00	Rb-Sr	Mussett *et al,* 1988
Rockall	granite		54.00	4.00	Rb-Sr	Hawkes *et al*, 1975
	granite		54.00	4.00	Rb-Sr	Hawkes *et al*, 1975
	granite		57.00	7.00	Rb-Sr	Hawkes *et al*, 1975
St Kilda	granite	Conachair	55.00	0.50	Rb-Sr	Brook, 1984

Table 2.3. A summary table of the most recent published radiometric ages for the British Tertiary Igneous Province, mostly taken from Mussett *et al*. 1988.

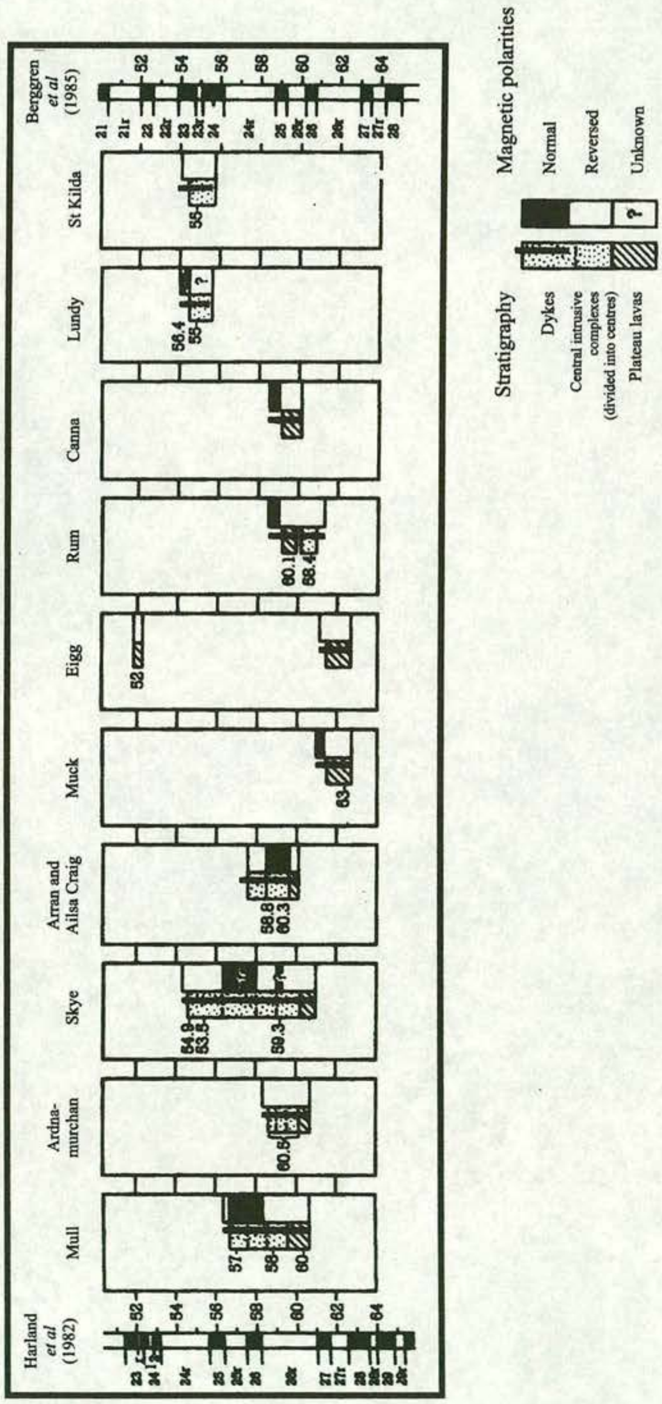


Figure 2.12. A summary diagram of magnetic polarity, geology and timing of individual centres in the British Tertiary Igneous Province, taken from Emeleus and Gyopari (1992).

Lavas	Sub-volcanic complex	Lavas older than complex	Evidence	Reference
Skye	Skye	yes	intrusional contact thermal metamorphism	Harker (1904)
Skye	Rum	no	clasts derived from complex are interstratified with lavas	Williamson and Bell (1994)
Mull (N), Eigg lava formation	Rum	yes	invaded by dykes of Rum swarm, then dykes are cut by complex	Emeleus (1997)
Mull (S)	Mull	yes	intrusional contact	Bailey *et al* (1924)
Mull (NE)	Ardnamurchan	yes	ambiguous intrusive relationship	Richey and Thomas (1930)
Antrim	Mourne	not known from field relationships		
Antrim	Slieve Gullion	yes?	large basalt blocks tentatively identified as lavas	Richie and Thomas (1932)
Antrim	Carlingford	yes	altered lavas preserved around the margins of the central complex	Le Bas (1965)

Table 2.4. Details of stratigraphic relationships between individual centres of the British Tertiary Igneous Province, taken from Bell and Jolley (1997).

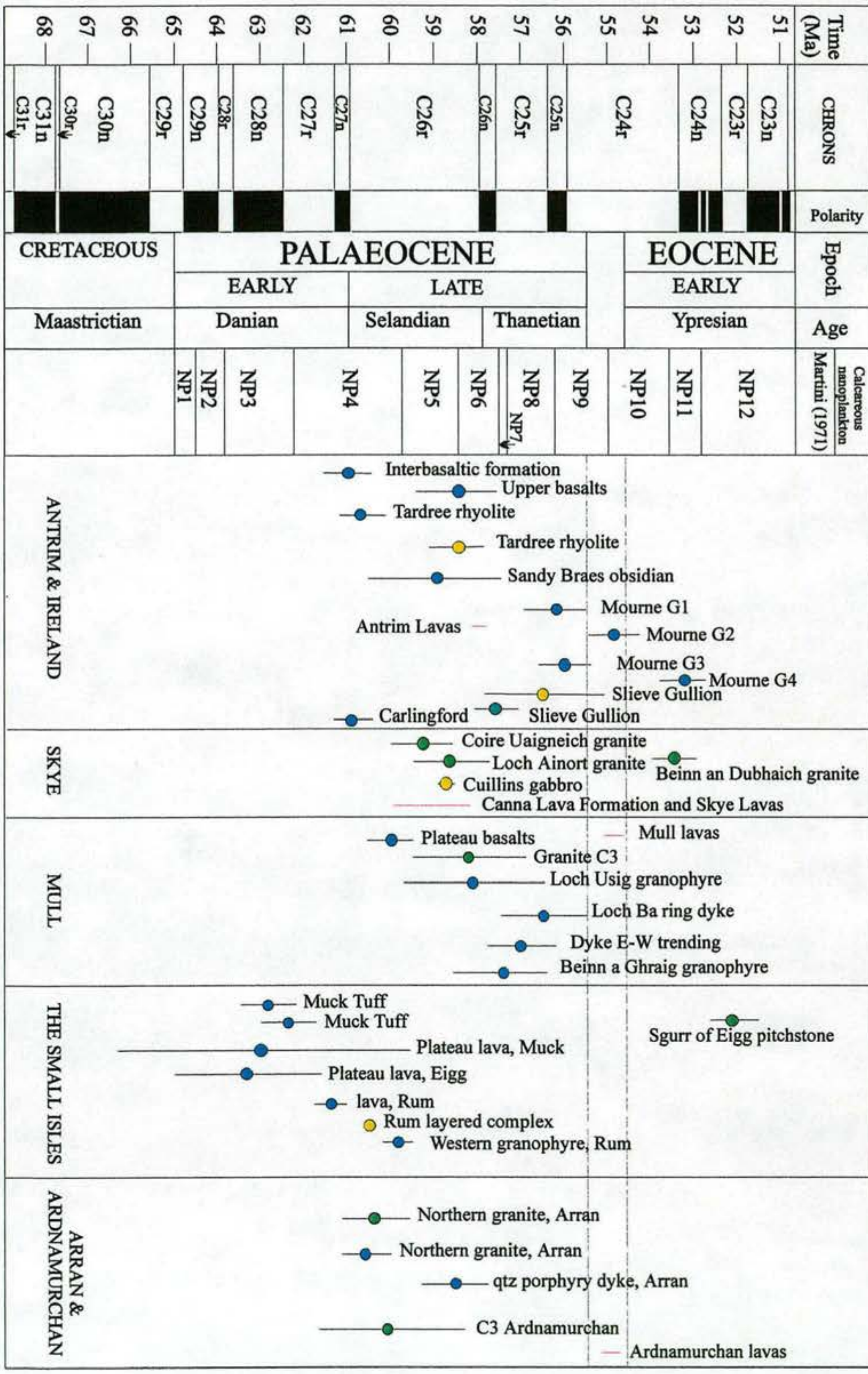


Figure 2.13. The radiometric ages detailed Table 2.3 shown on the geomagnetic time scale of Berggren *et al.* (1995). Igneous activity in the BTIP is shown to span 8 m.y. Palynological ages for the BTIP (Bell and Jolley, 1997; Jolley, 1997) are plotted as red lines. Light blue = $^{40}Ar/^{39}Ar$ age; yellow = U/Pb age; green = Rb-Sr age.

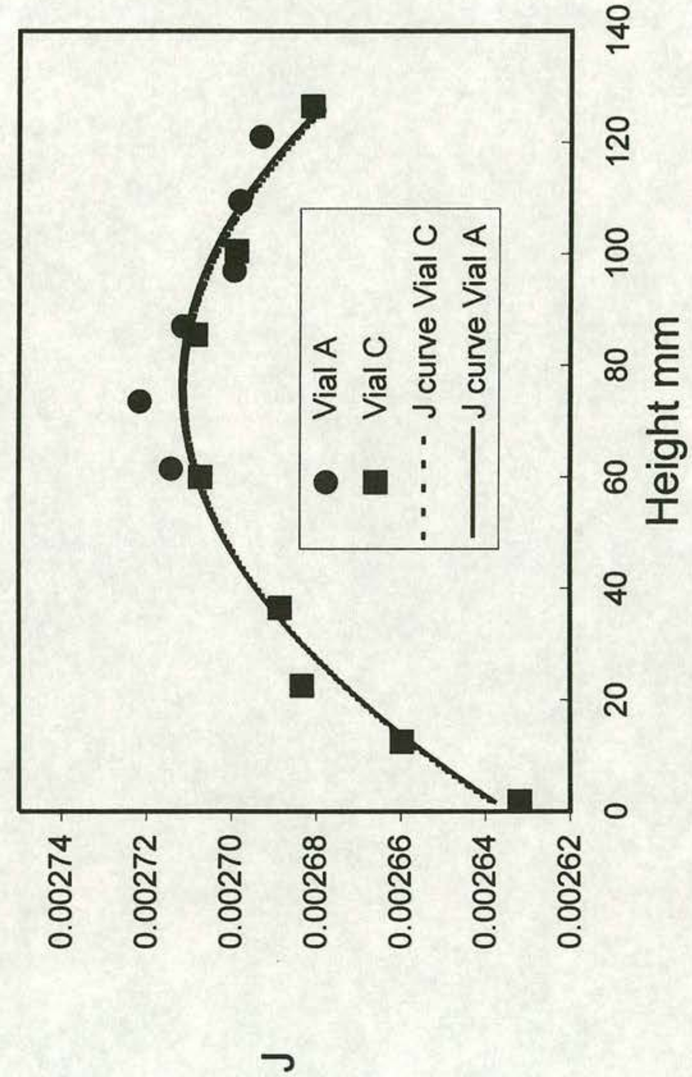


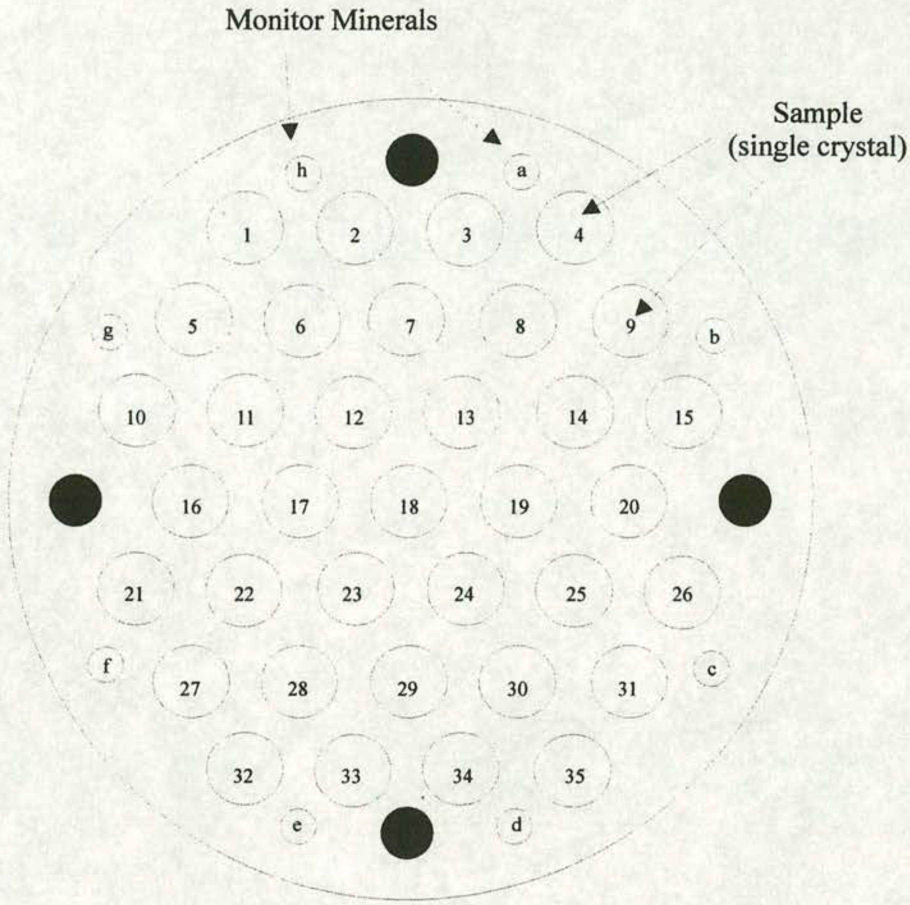
Figure 3.1. A J curve for irradiation EK33. The values of J can be directly read off the graph using the height (mm) of the sample within the glass vial.

Argon isotope produced	Calcium	Potassium	Argon	Chlorine
^{36}Ar	$^{40}Ca(n,n\alpha)^{36}Ar$			$^{35}Cl(n,\gamma)^{36}Cl$ - ^{36}Ar
^{37}Ar	$^{40}Ca(n,\alpha)^{37}Ar$	$^{39}K(n,nd)^{37}Ar$	$^{36}Ar(n,\gamma)^{37}Ar$	
^{38}Ar	$^{42}Ca(n,\alpha)^{38}Ar$	$^{39}K(n,d)^{38}Ar$	$^{40}Ar(n,nd)^{38}Cl$ - ^{38}Ar	$^{37}Cl(n,\gamma)^{38}Cl$ - ^{38}Ar
^{39}Ar	$^{42}Ca(n,\alpha)^{39}Ar$	$^{39}K(n,p)^{39}Ar$	$^{38}Ar(n,\gamma)^{39}Ar$	
	$^{43}Ca(n,n\alpha)^{39}Ar$	$^{40}K(n,d)^{39}Ar$	$^{40}Ar(n,d)^{39}Cl$ - ^{39}Ar	

Table 3.1. Details of reactions that generate interfering isotopes during the irradiation of a sample.

	EK37 Petten	EK35 Petten	EK33 Oregon	EK29 Oregon
(MWH)	12	4	16	8
36/37(Ca)	0.000273	0.000273	0.000264	0.000264
error	0.000003	0.000003		
40/39(K)	0.00029	0.00019	0.00086	0.00086
error	0.00019	0.00049		
39/37(Ca)	0.000699	0.000699	0.000673	0.000673
error	0.000013	0.000013		
38/39(Ca)	0.01208	0.01149	0.01211	0.01211
error	0.00002	0.00003		
38/37(Ca)	0.000721	0.000721	0.00002	0.00002
error	0.000078	0.000078		

Table 3.2. Correction factors for the K and Ca derived isotopes during irradiation at the USGS TRIGA reactor, USA, and the Petten RODEO reactor in The Netherlands.



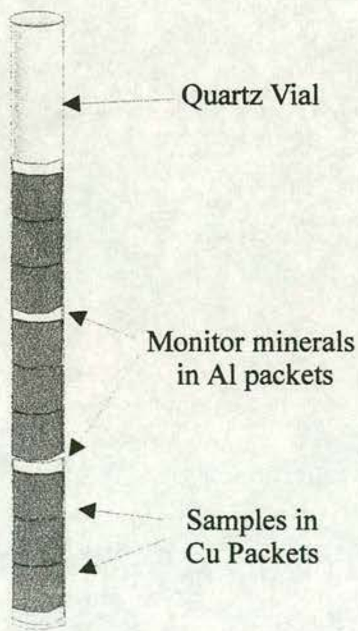


Figure 3.2. Two schemes for the position of the monitor minerals used in this study. Example A where the monitor minerals are located in holes a-h in copper trays. The unknowns are located in holes 1-31, and Example B where the monitor minerals are loaded into Al foil packets and stacked between the unknowns in quartz vials.

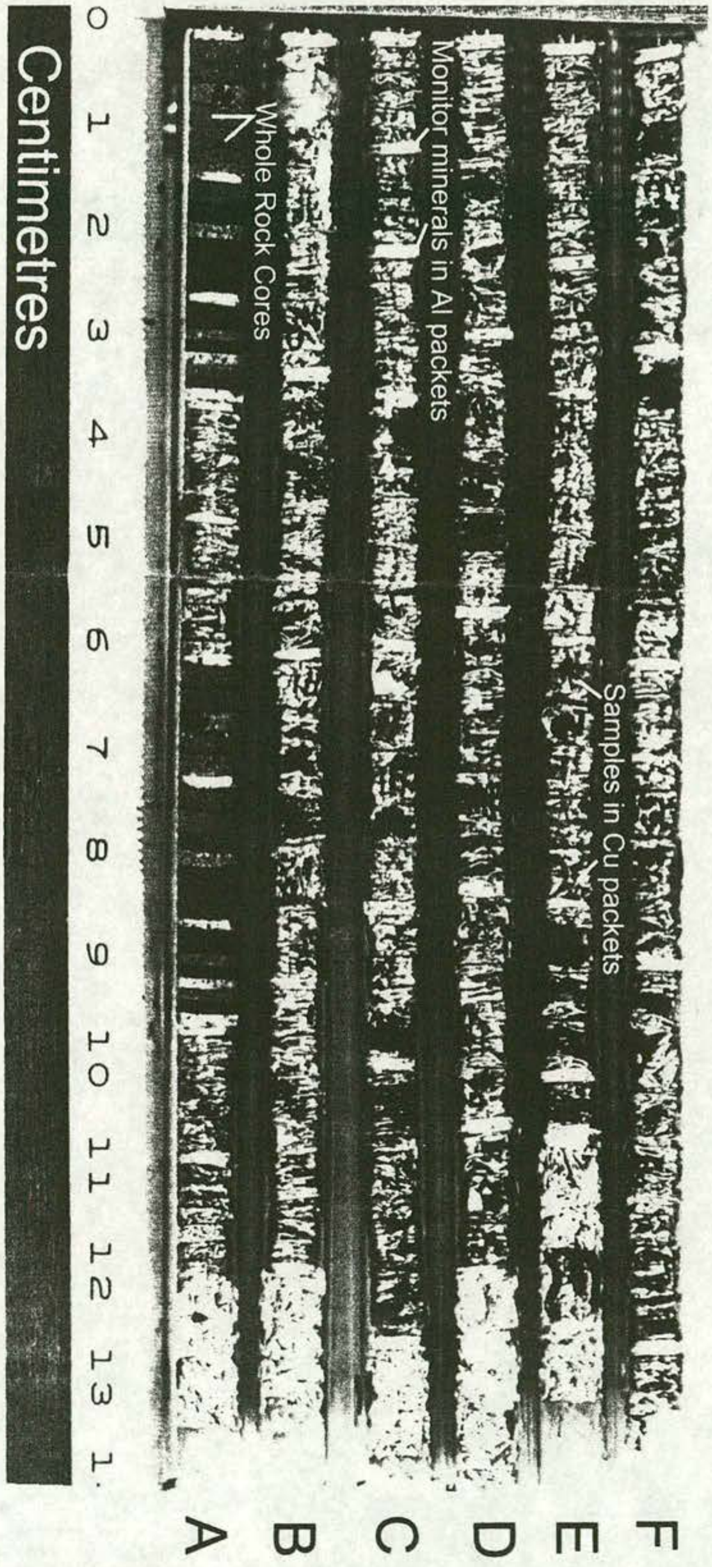


Figure 3.3. The position of the monitor minerals and unknowns during irradiation EK33. The whole rocks cores, samples in copper packets and the monitor minerals in Al packets can be seen.

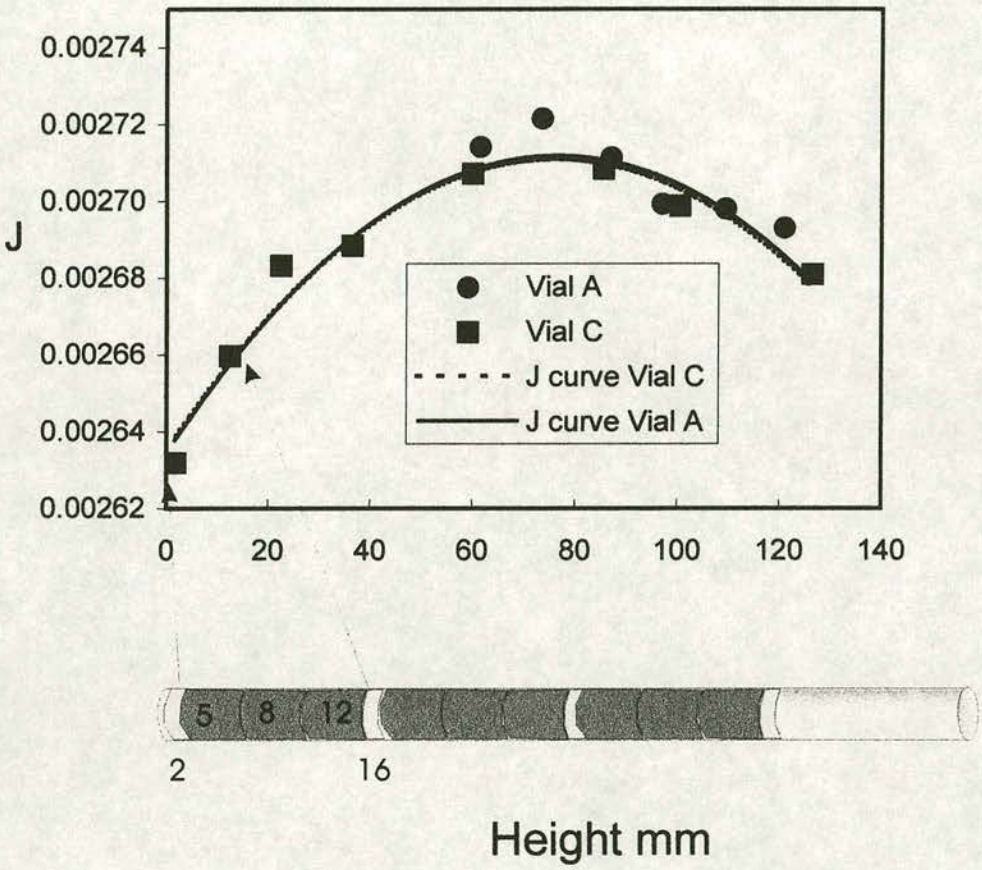


Figure 3.4. A J curve for irradiation EK33. Values of J can be read off the graph using the known height of packets in the vials, which are shown schematically.

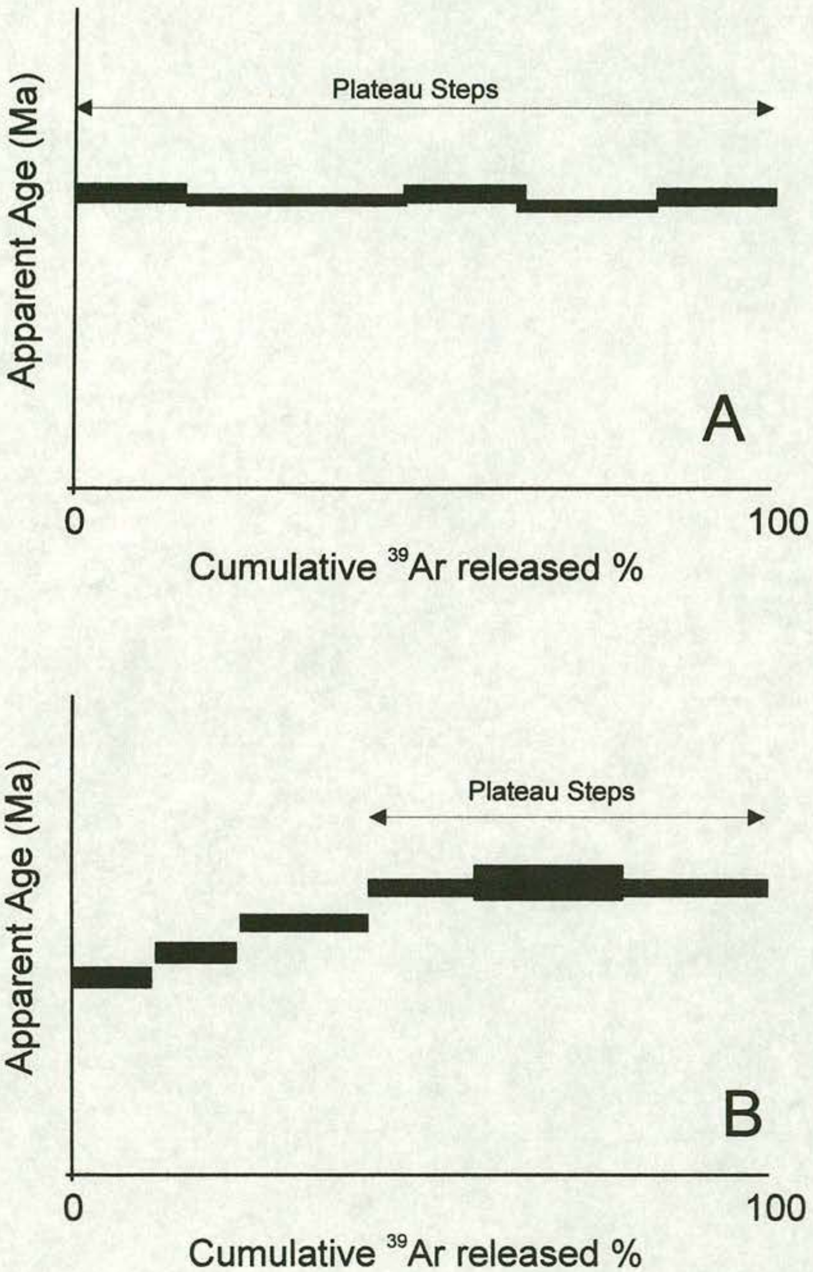


Figure 3.5. Two schematic age spectra diagrams, one showing an undisturbed system where the $^{40}Ar/^{39}Ar$ ratio is constant showing that the system has been closed. Example B shows the effects of an open system where argon has been lost. The high temperature steps reach a plateau which represents the age of the sample.

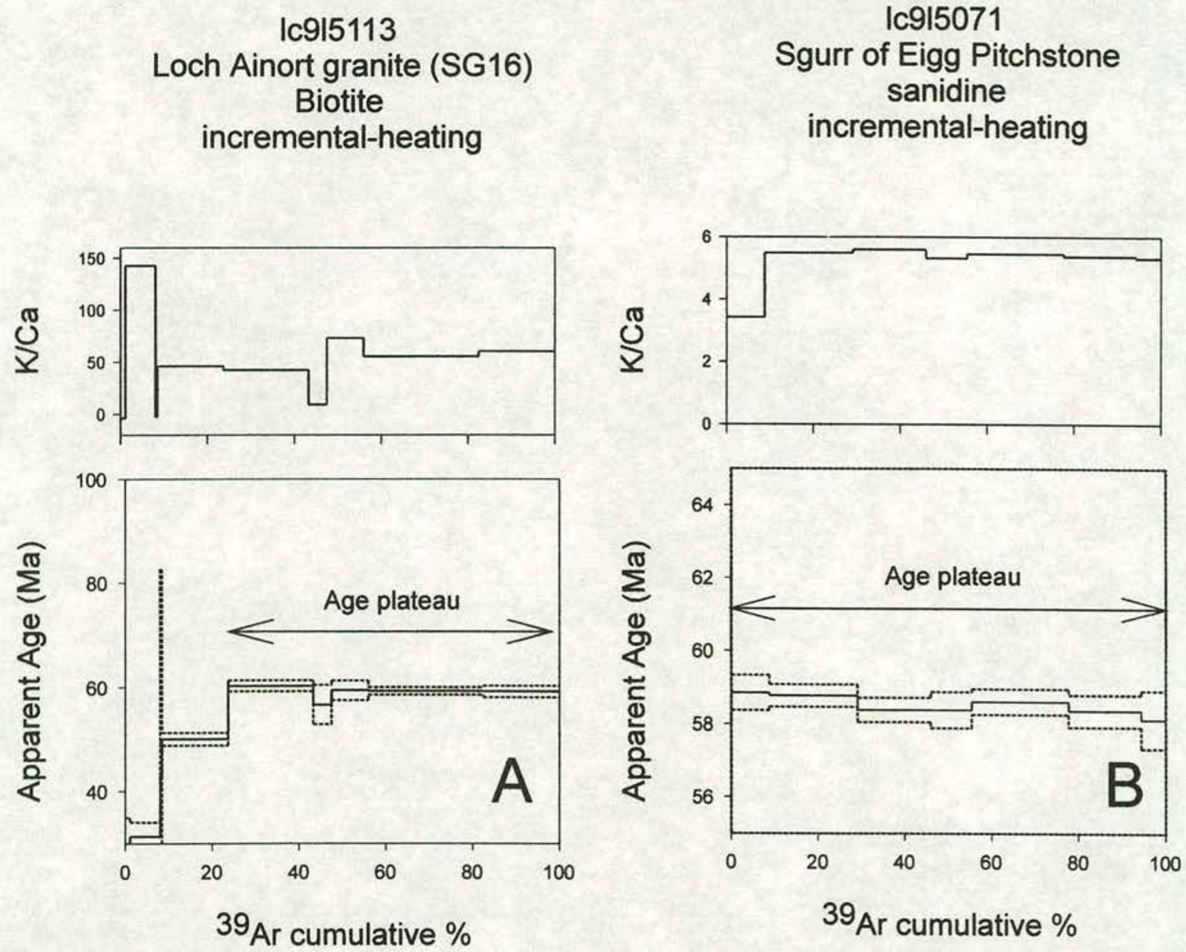


Figure 3.6. Two age spectra from this study that show the effects of an open system (A), and a closed system (B). The flat plateau of example B indicates that no argon has been lost or gained since crystallisation, whereas example A shows argon loss during the low temperature steps resulting in young apparent ages. Example A reaches a plateau giving the true age of the sample at high temperatures.

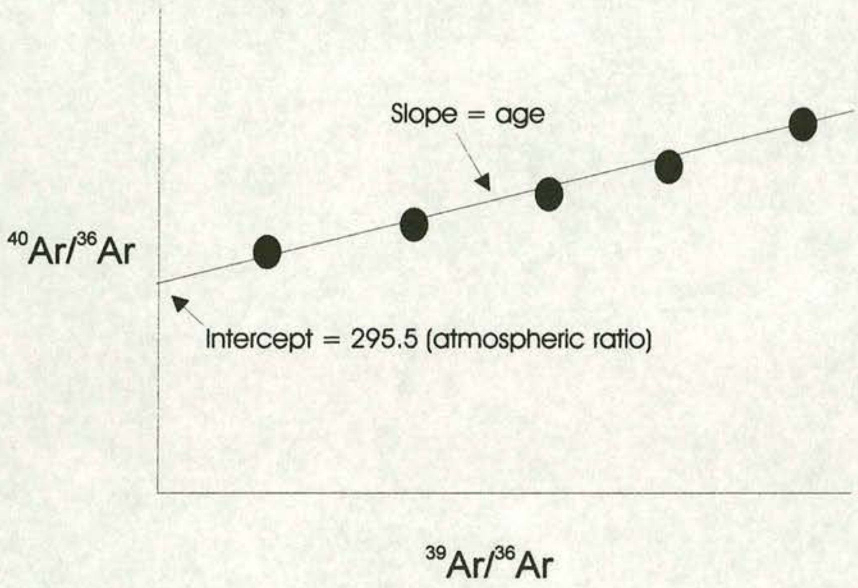


Figure 3.7. An isochron plot with $^{40}Ar/^{36}Ar$ versus $^{39}Ar/^{36}Ar$. The slope of the line (isochron) represents the age of the sample. The intercept on the Y axis should be the atmospheric argon ratio, 295.5.

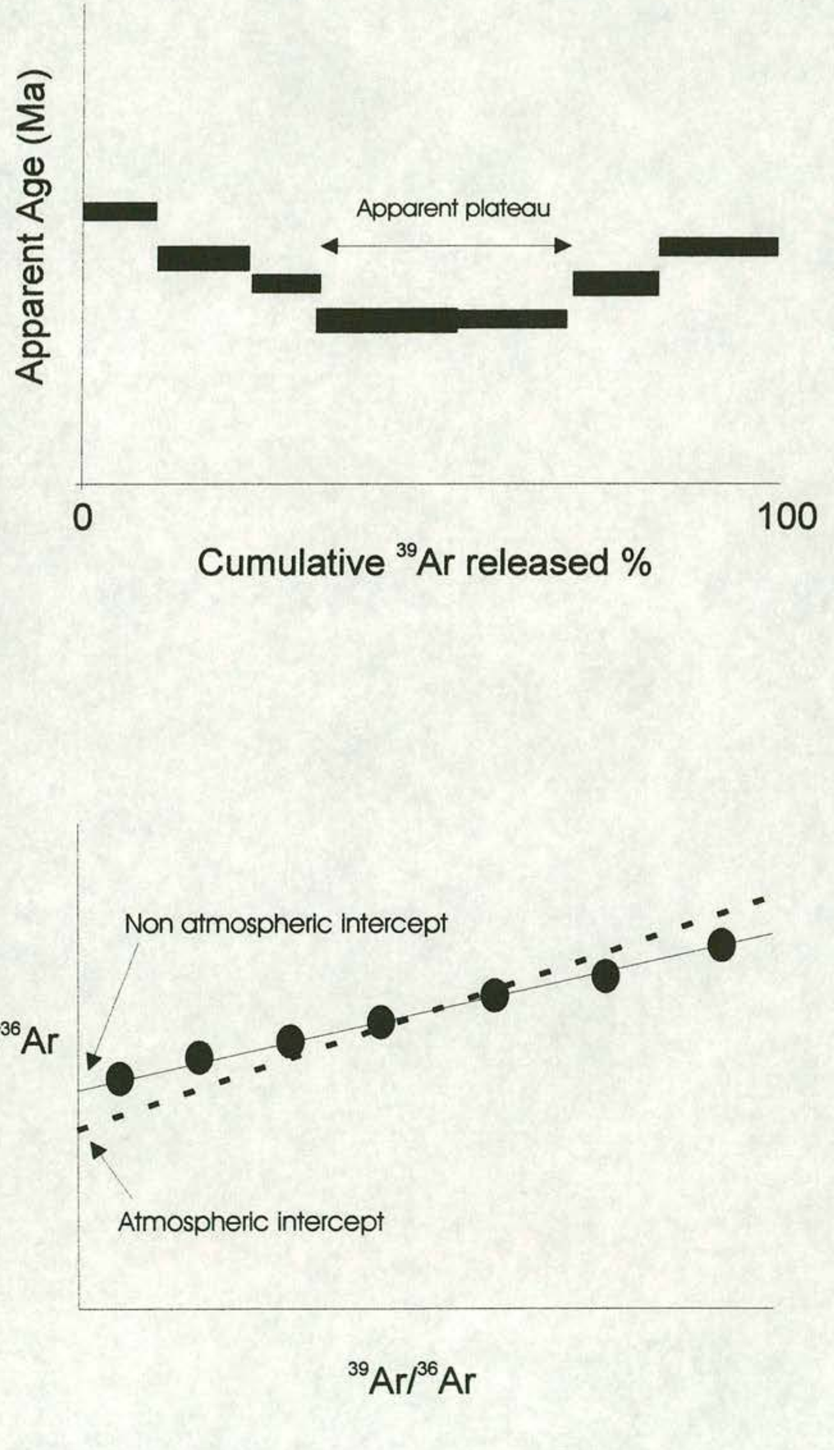


Figure 3.8. A schematic saddle shaped age spectra. This type of age spectrum is common in rocks with excess argon. The isochron plot shows the existence of excess argon by having an intercept that is not atmospheric (high $^{40}Ar/^{36}Ar_{(air)}$ ratio).

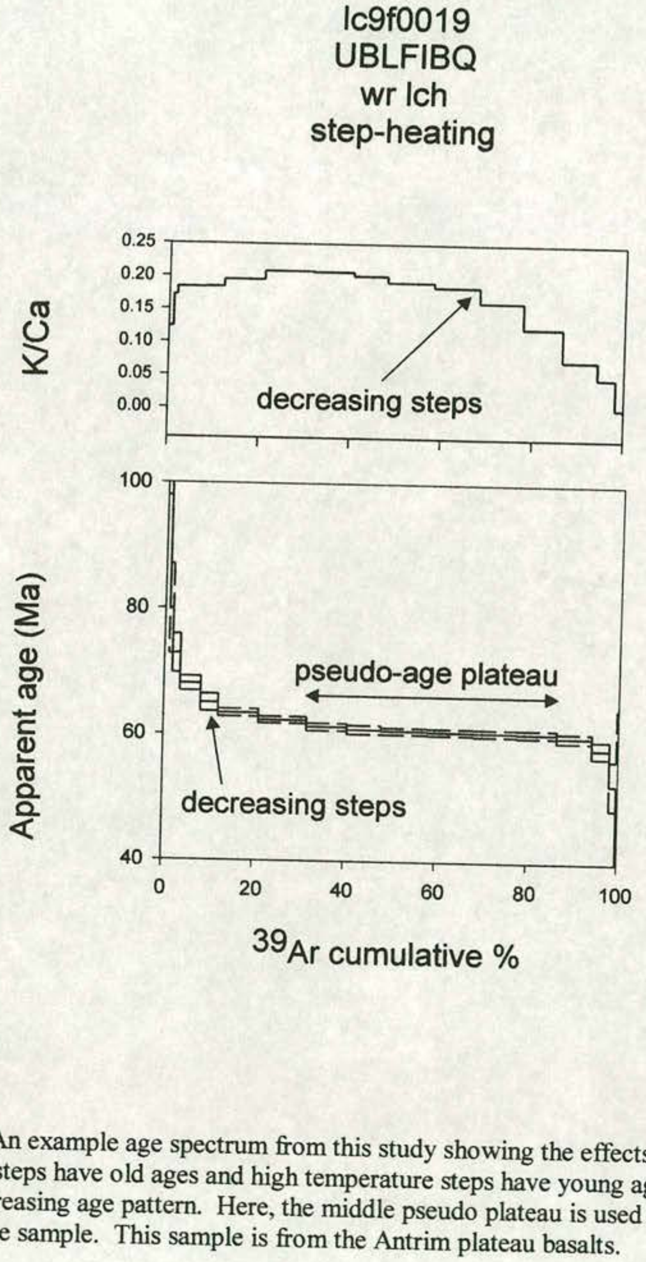


Figure 3.9. An example age spectrum from this study showing the effects of argon recoil. Low temperature steps have old ages and high temperature steps have young ages. This results in a stepwise decreasing age pattern. Here, the middle pseudo plateau is used to give an indication of the true age of the sample. This sample is from the Antrim plateau basalts.

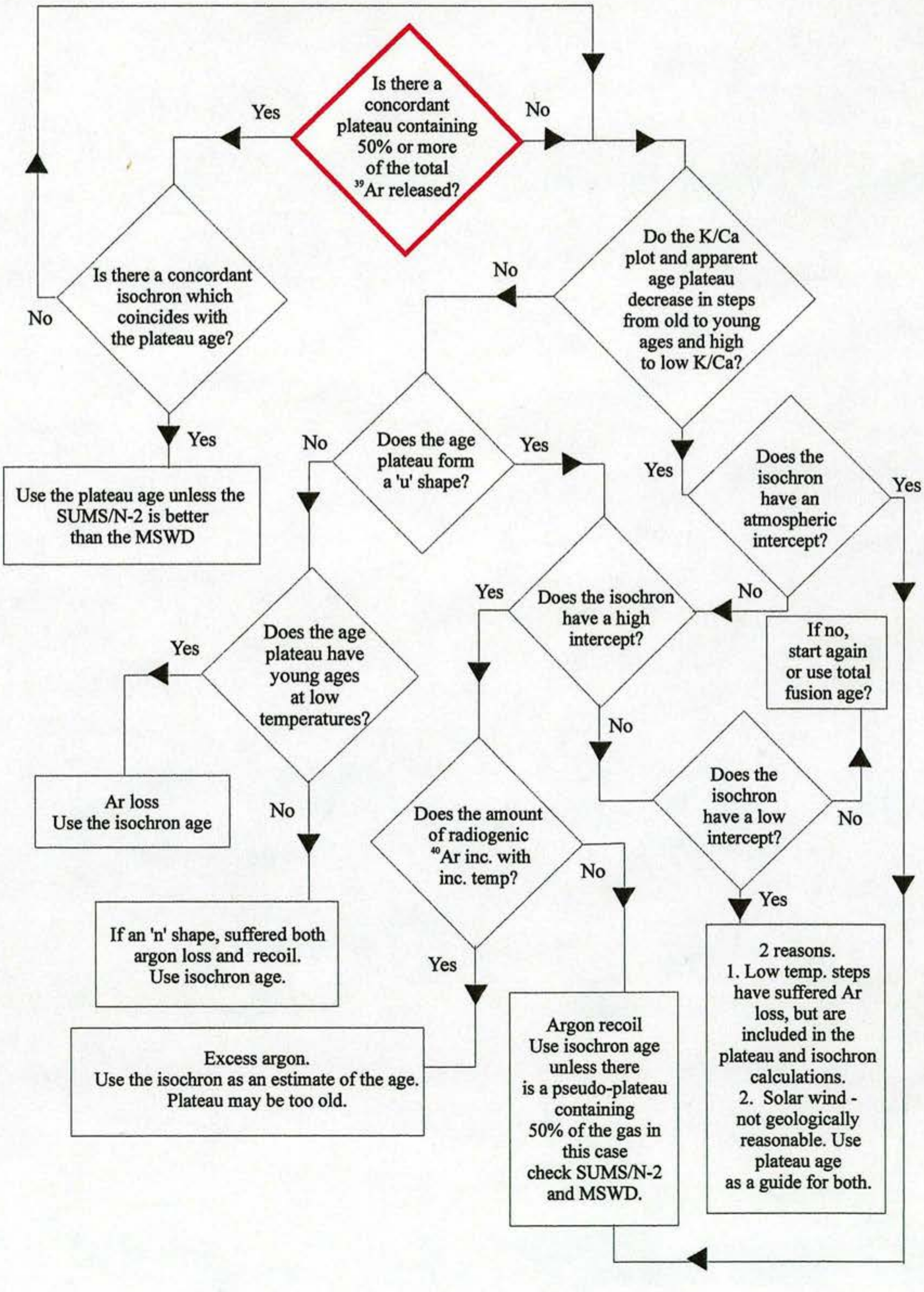


Figure 3.10. A flow chart detailing the process of evaluating age spectrum and isochron ages. The start is coloured red.

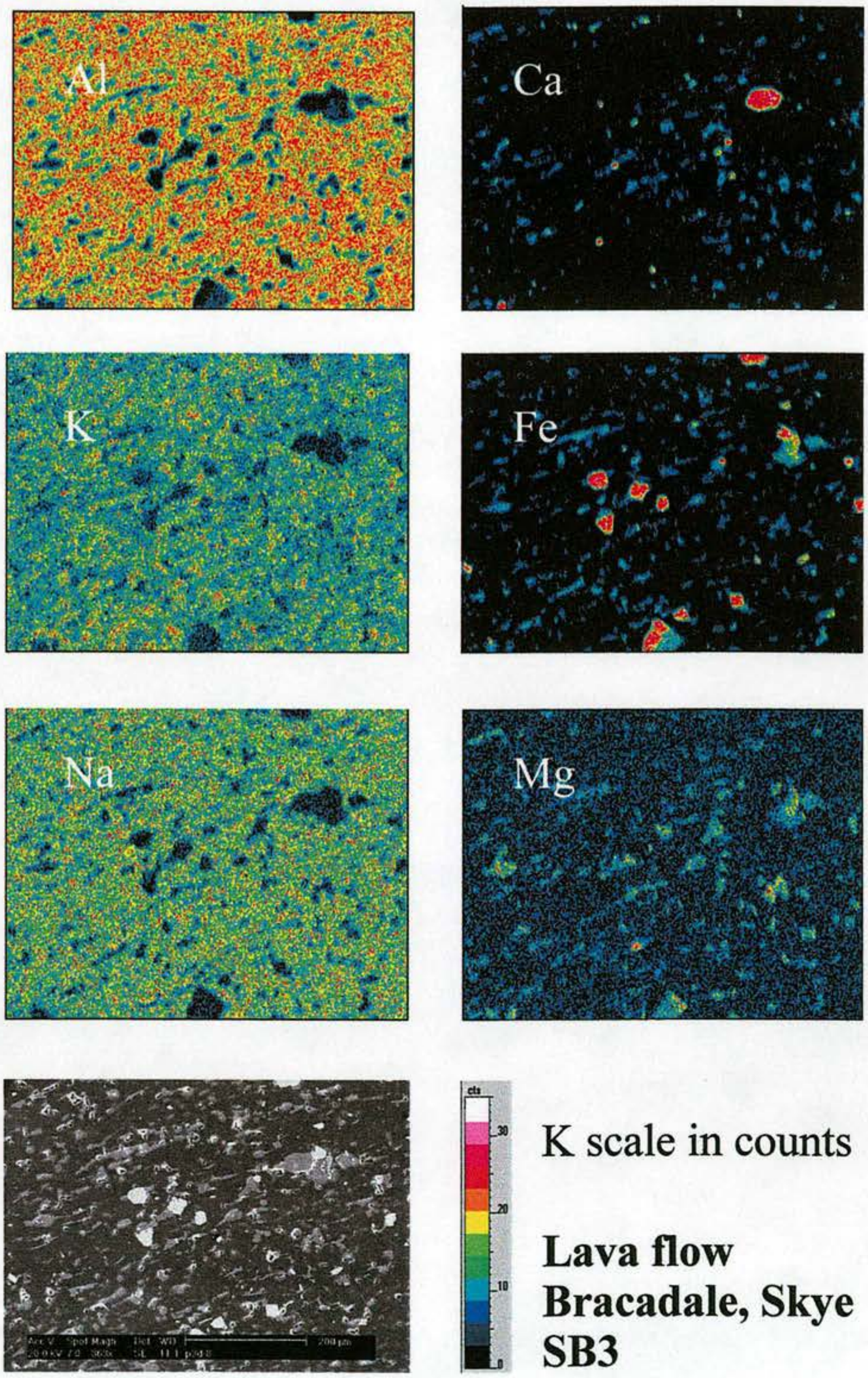


Figure 3.11. An element map for sample SB3 that yielded a good $^{40}Ar/^{39}Ar$ age. The K is located in the main crystal phases that are not altered. The K scale is in counts to the ED detector in 3 minutes.

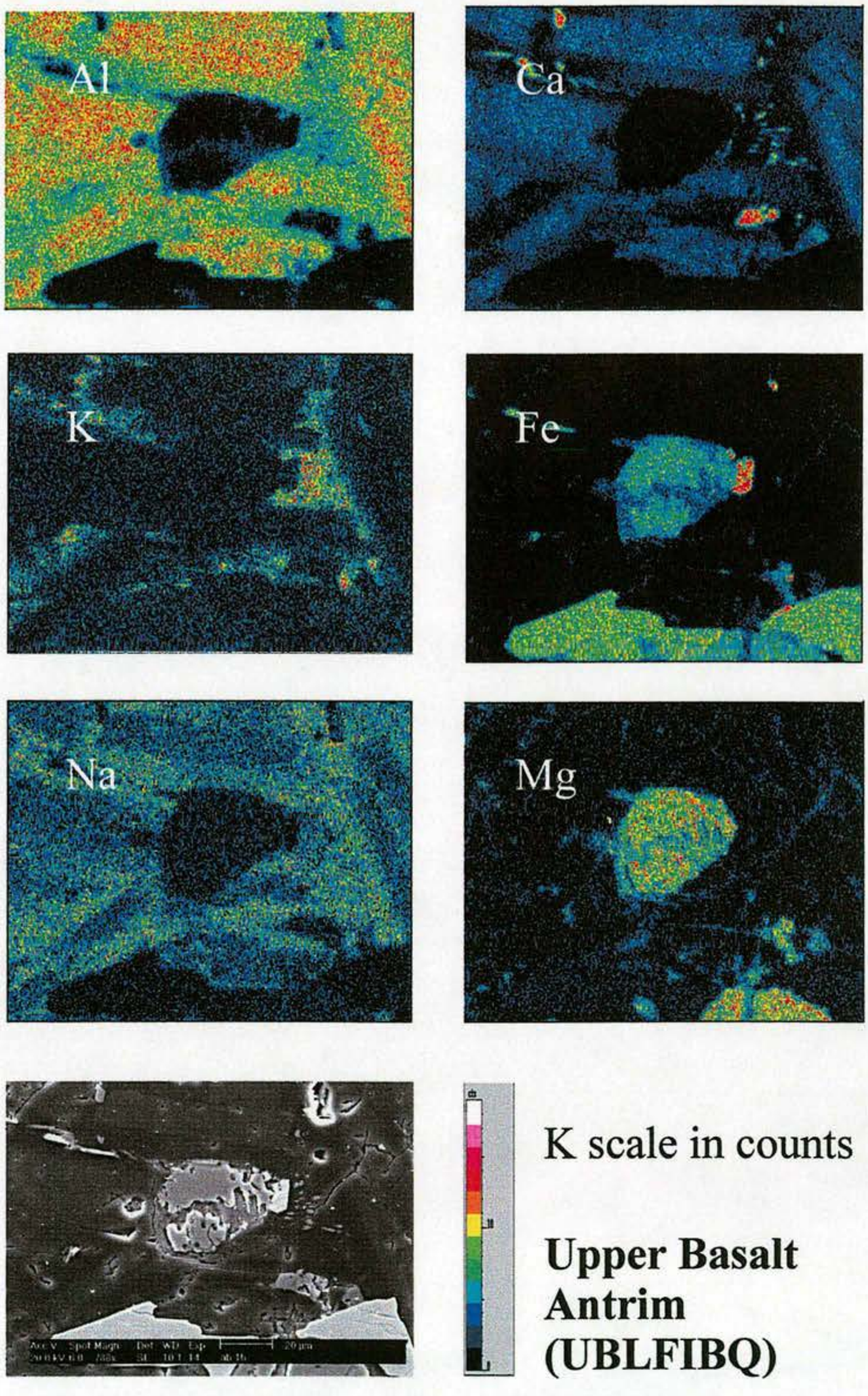


Figure 3.12. An element map for sample UBLFIBQ. This sample showed the effects of argon recoil as a result of alteration. The K is distributed in alteration phases located at the grain boundaries. K scale is in count to the ED detector in 3 minutes. The total number of counts is low in this sample.

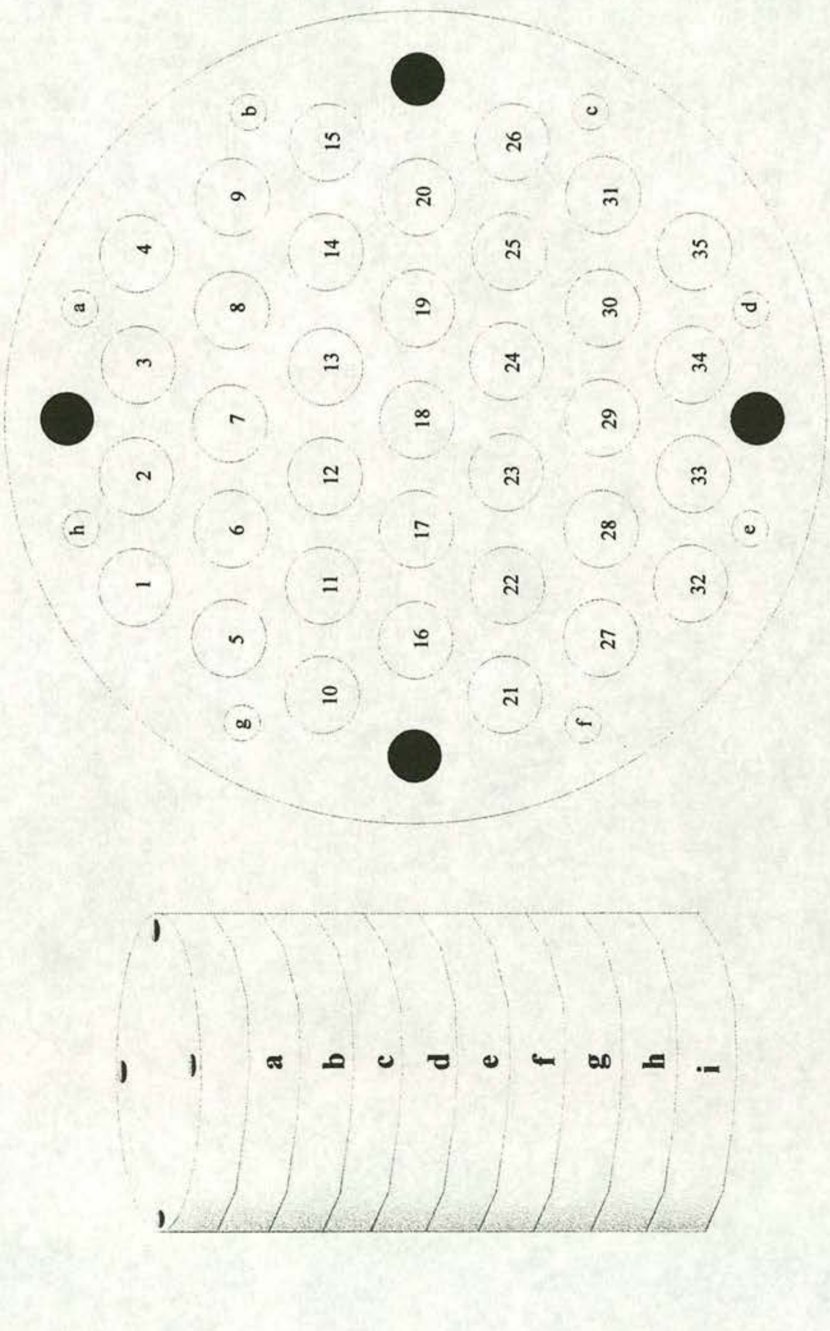


Figure 3.13. A schematic diagram showing the copper pans used to irradiate single crystals. Samples were loaded into holes 1-31 and the monitor minerals in a-h and hole 18. The copper pans were then joined together for irradiation.

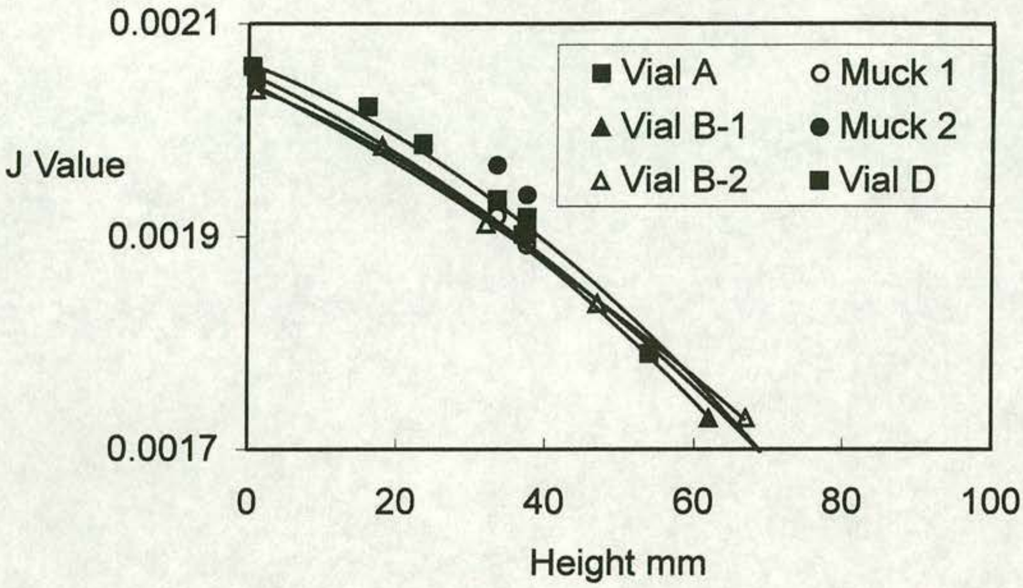


Figure 3.14. The J curve for irradiation EK29.

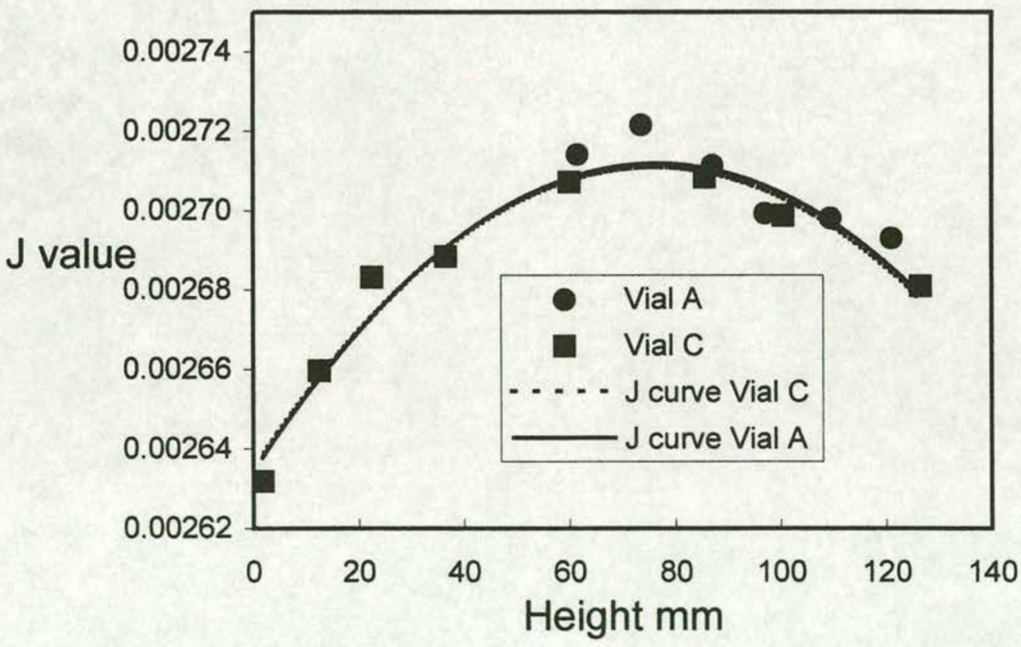


Figure 3.15. The J curve for irradiation EK33.

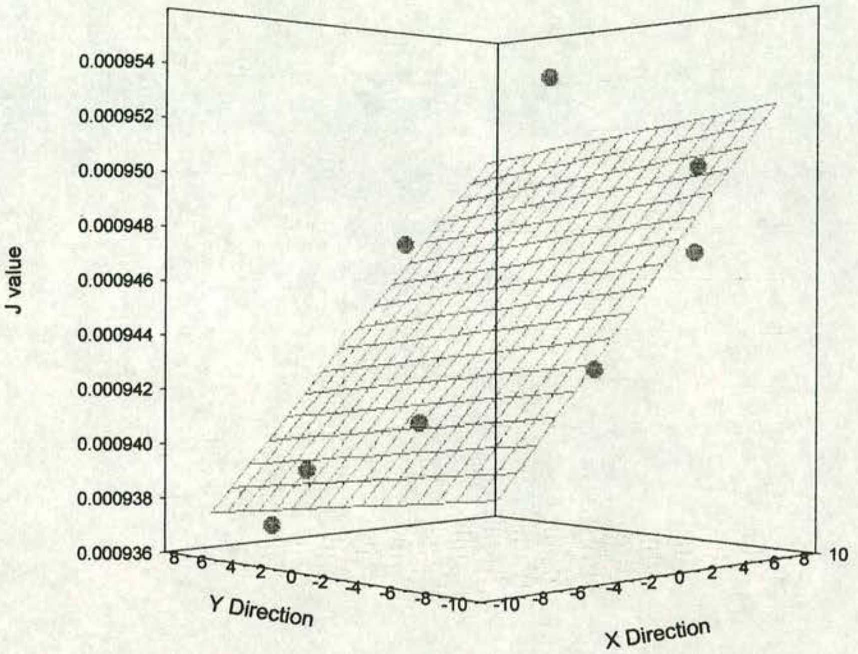


Figure 3.16. J values for monitor minerals in pan F, irradiation EK35. Tilting of the copper pans during irradiation has caused a tilting of the plane regressed through the data.

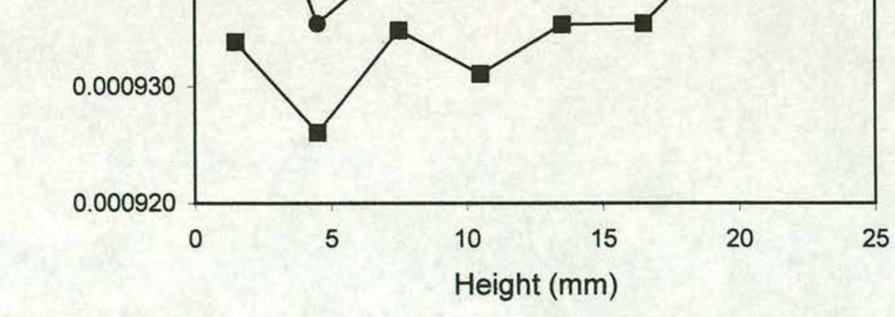


Figure 3.17. Monitor minerals from irradiation EK35 located in hole 18 and a-h are shown on a plot of J with position. A significant difference in J values from the outer ring of monitors to the middle hole is seen.

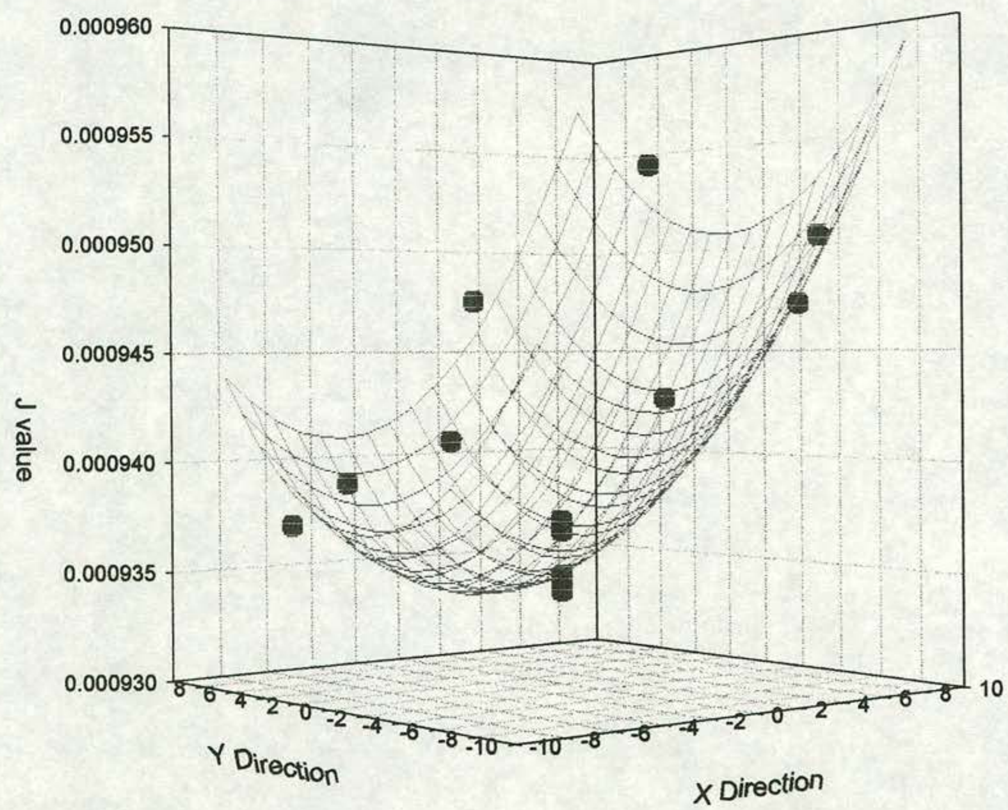


Figure 3.18. A paraboloid can be regressed through the monitor data. This paraboloid can be used to calculate individual J values for each hole in the pan using X, Y co-ordinates.

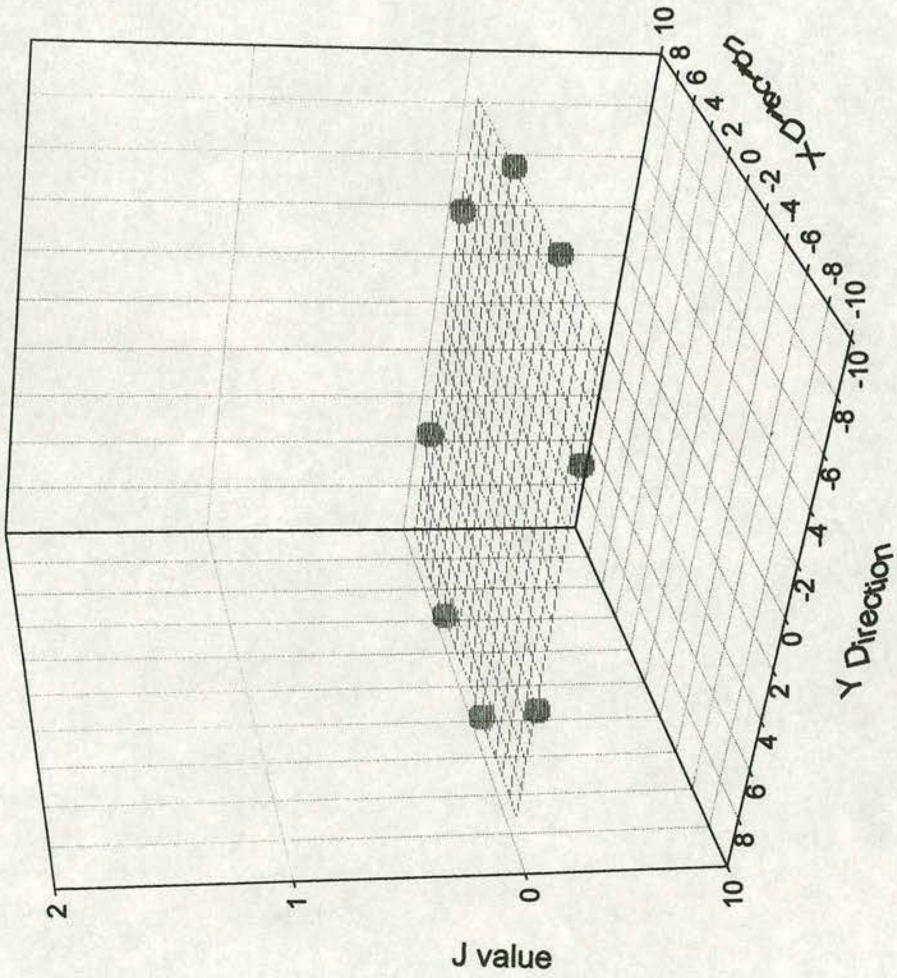


Figure 3.19. The J values for pan F, irradiation EK 35, are corrected for tilt and now plot as a flat plane.

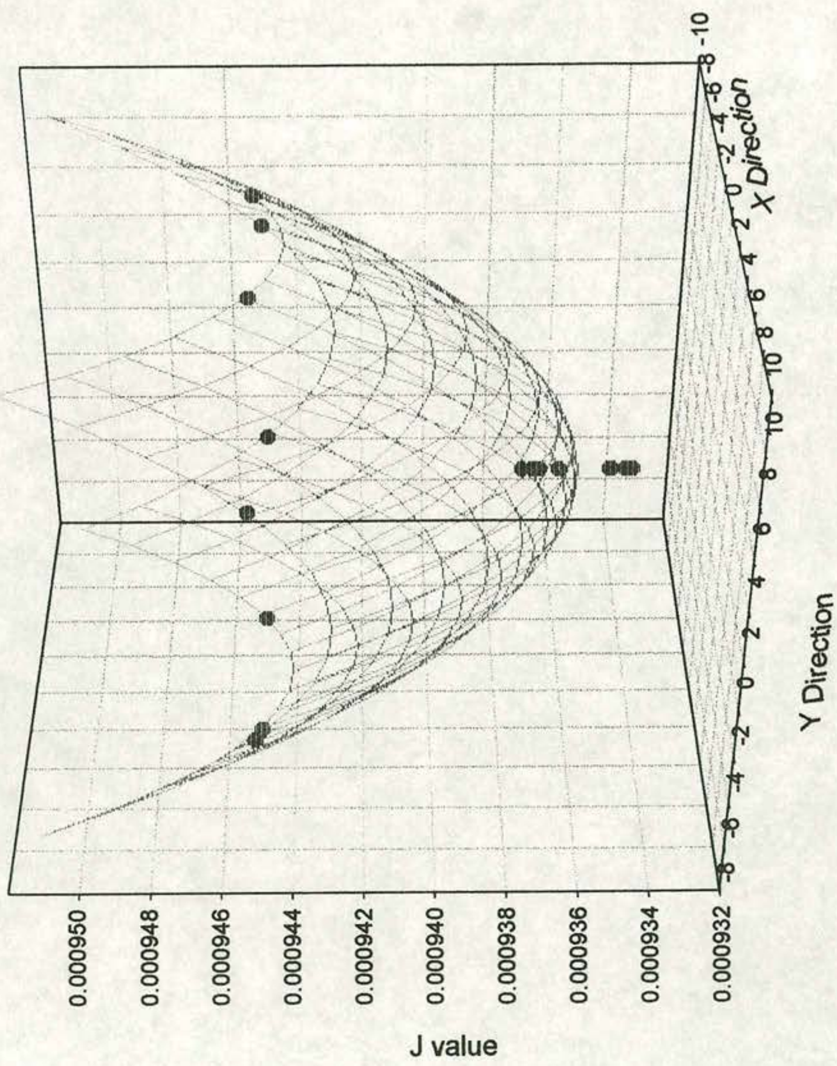


Figure 3.20. The a-h J values and the hole 18 J values are corrected for tilt. The paraboloid is the result of shielding by the copper. The paraboloid allows individual values of J to be calculated for every hole in the pan.

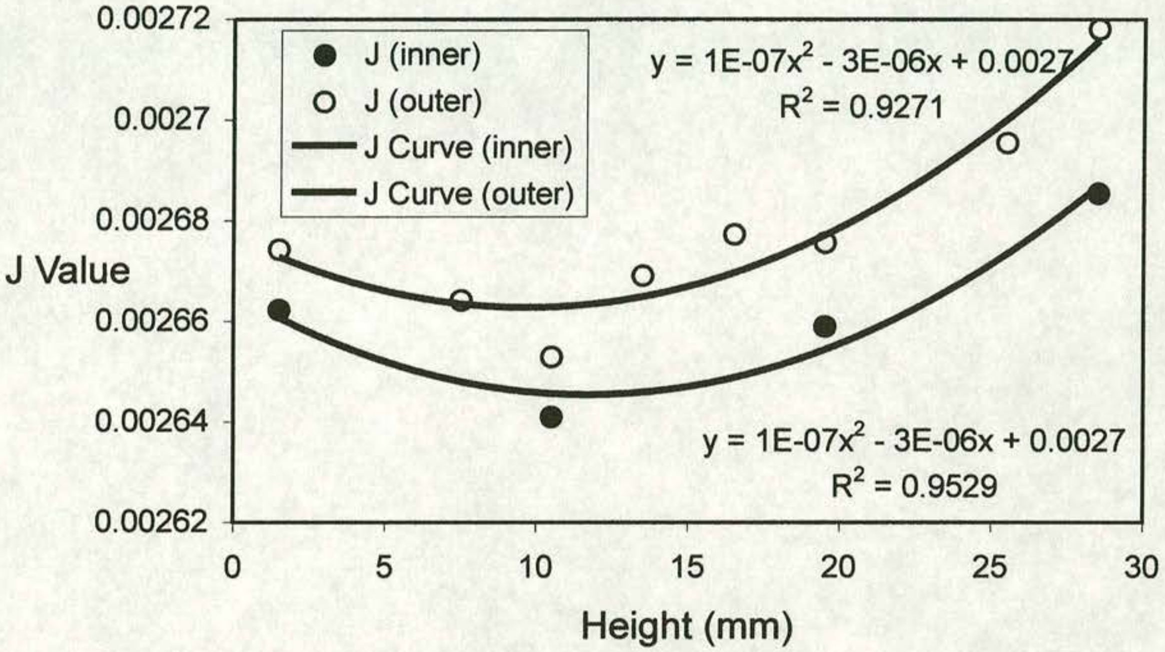


Figure 3.21. The J curve for EK37. The difference in J values for the outer ring of monitor minerals and the centre hole is still visible. The samples in this irradiation were located in alternate pans in the centre hole. J values for the samples were obtained by reading off the bottom line.

Label	Year	Exp. Type	Machine
lc8f0???	1998	furnace	Map 1
lc8l0???	1998	laser	Map 1
lc9f0???	1999	furnace	Map 1
lc9l5???	1999	laser	Map 2

Table 3.3. An explanation of experiment numbers used in the next chapter. Map 1 and Map 2 are described in the text.

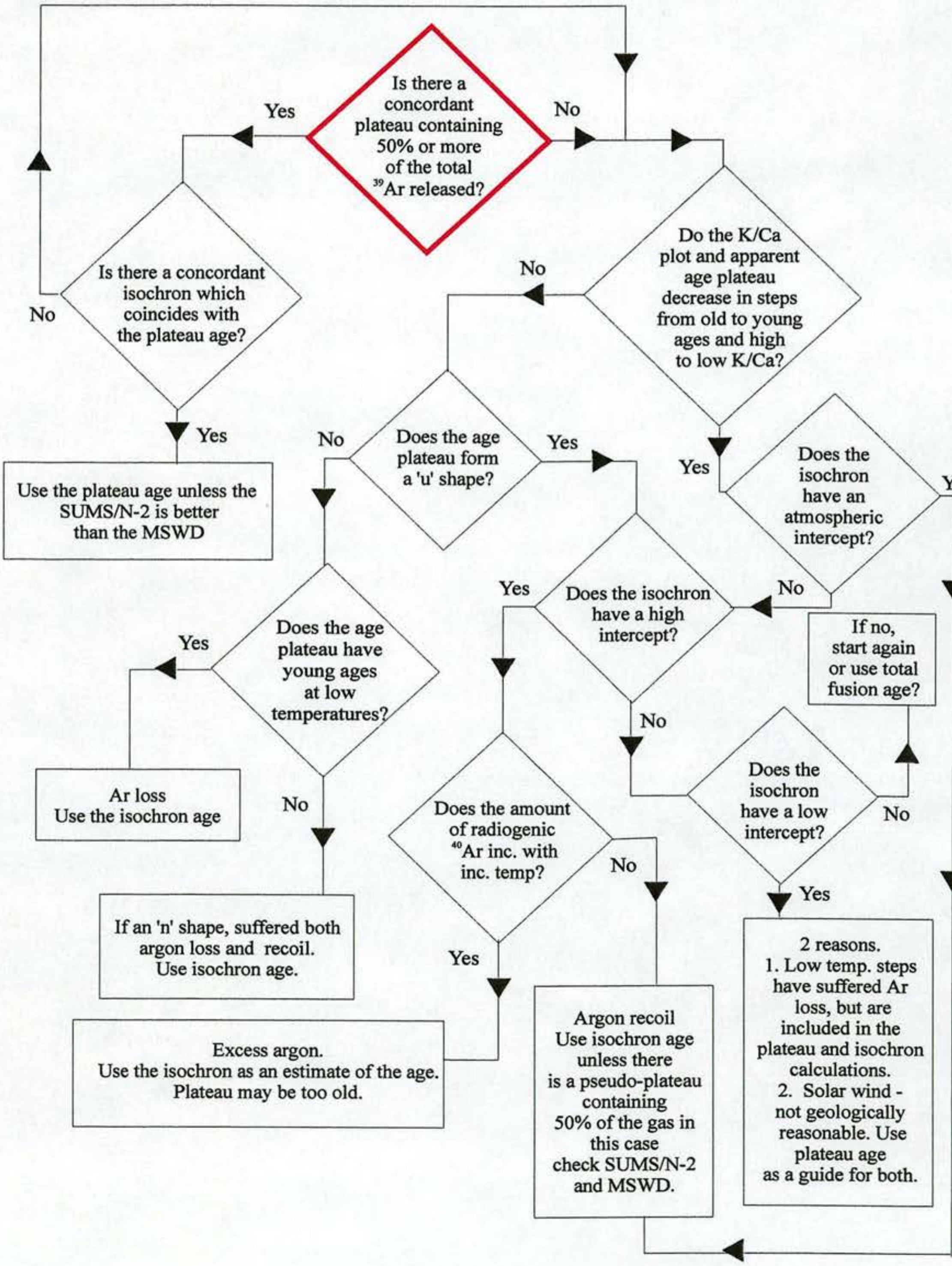


Figure 4.1. The flow chart, described in Chapter 3, used to summarise the decision making process involved in evaluating the age spectrum and isochron plots. The chart is based on the acceptance criteria of Singer and Pringle (1996) and Pringle (1992). The start is coloured red.

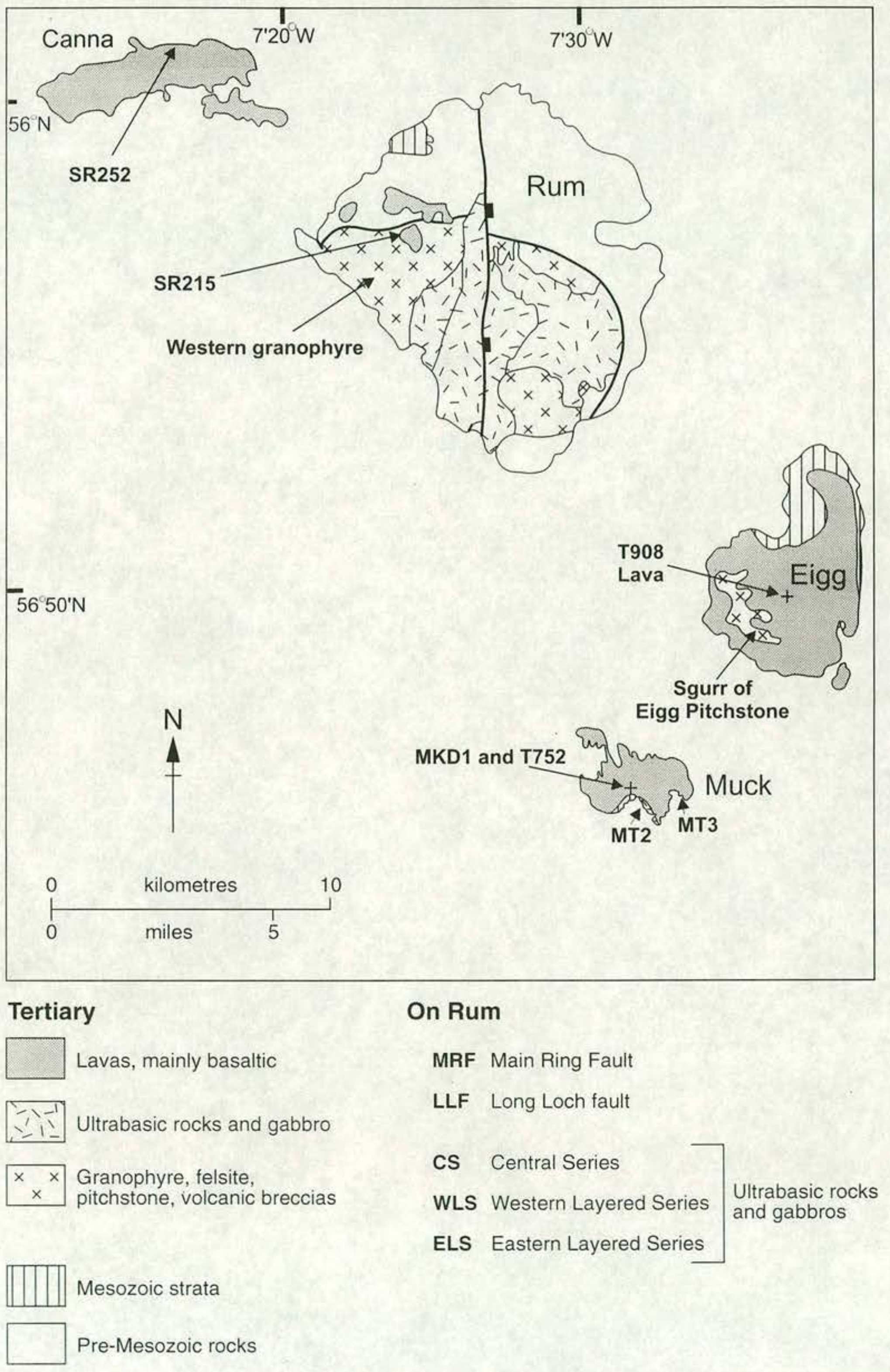


Figure 4.2. The sample localities are shown on a simplified geological map of the Small Isles, redrawn from Emeleus and Gyopari (1992).

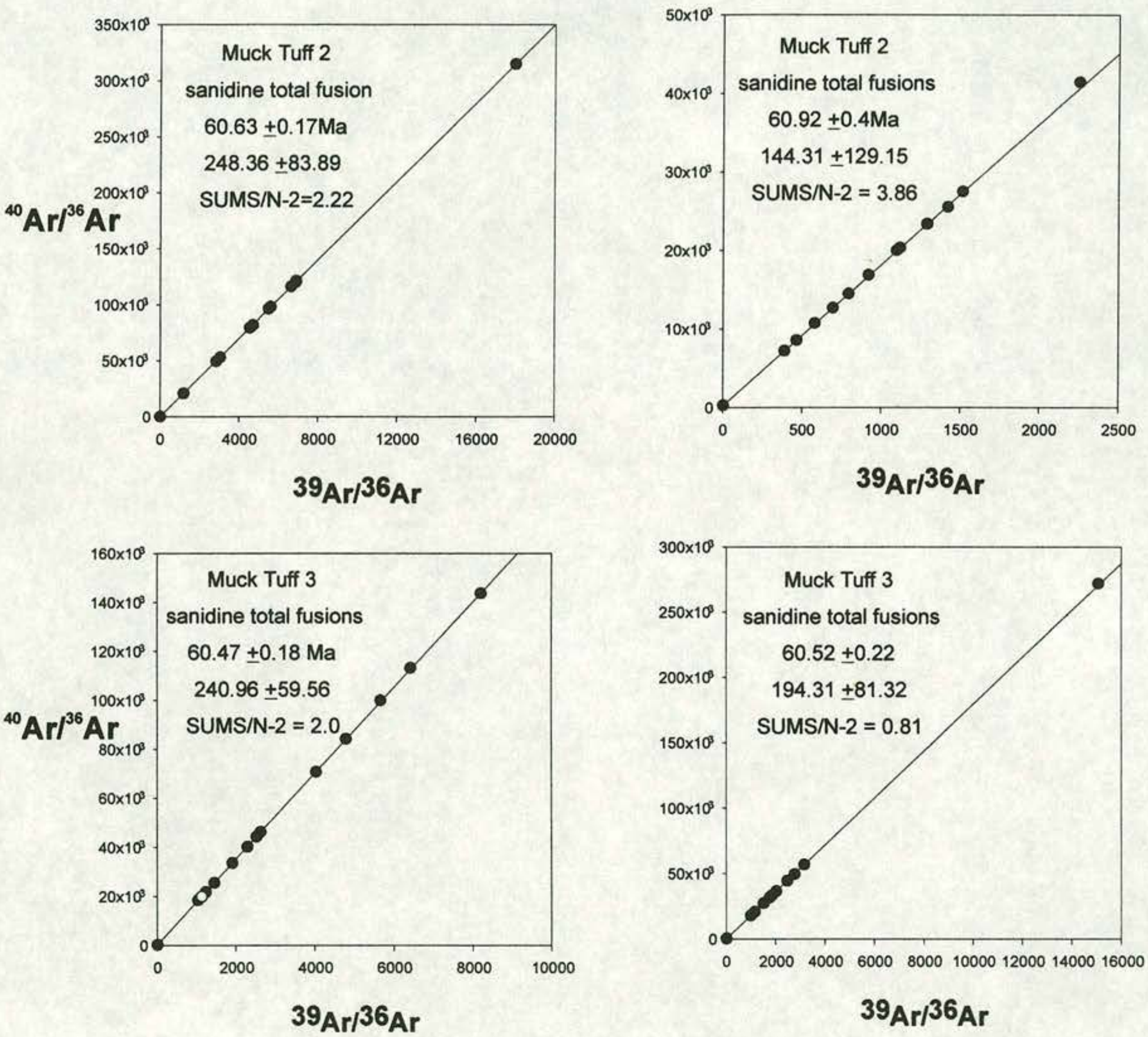


Figure 4.3. Single crystal total-fusion isochrons for samples MT2 (top) and MT3 (bottom).

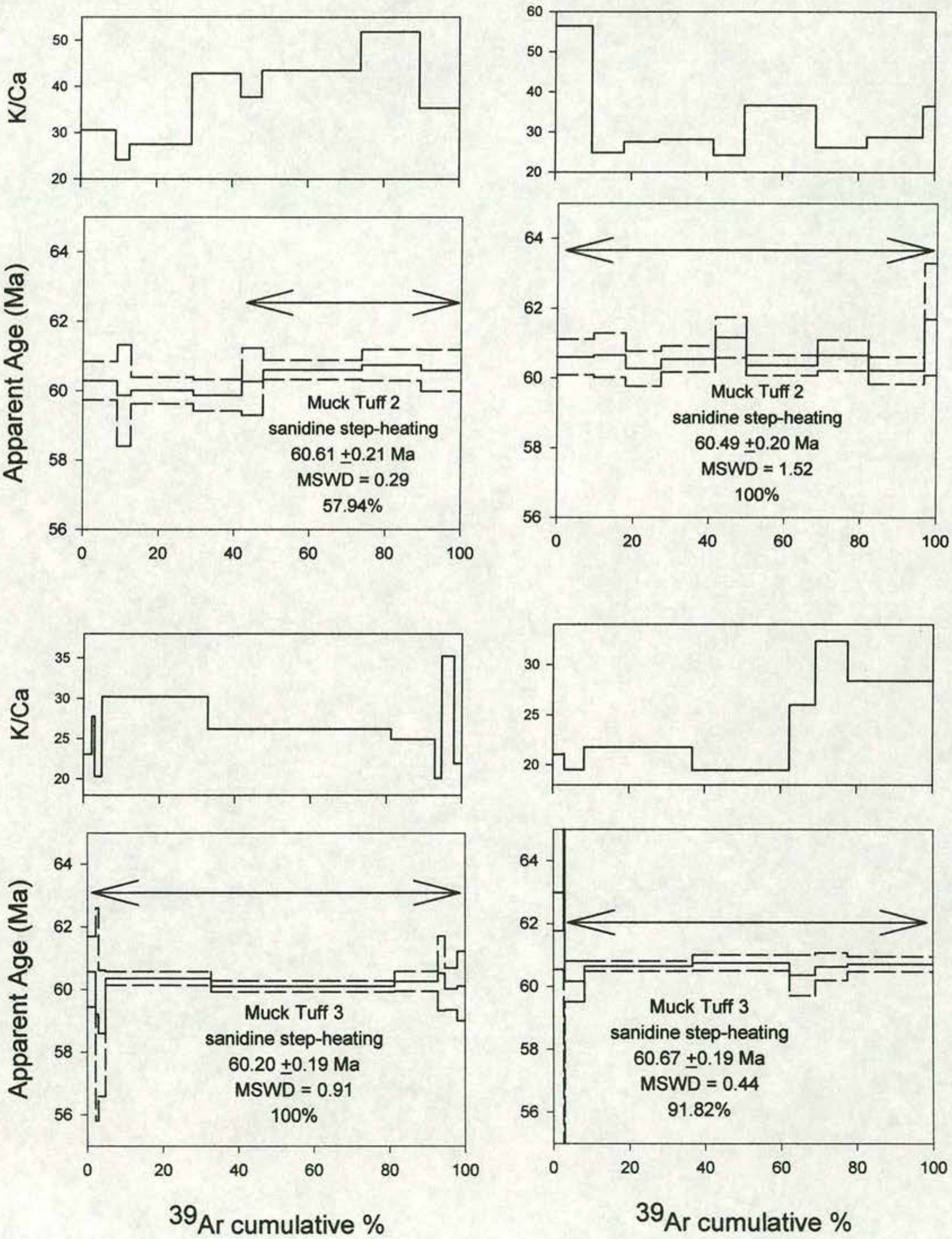


Figure 4.4. Example age spectrum diagrams for samples MT2 (top) and MT3 (bottom). The flat plateaus shows that minimal disturbance of the system has occurred.

Sample	Name	Material	J value	Sd J	Steps	TF age	Error	Total K/Ca	WMPA	Sd	MSWD	Cum. Ar%	Iso age	Error	Sums/n-2	Intercept	Error
MT2	Muck tuff 2	sanidine	0.001952	0.25	11 of 13	60.5	0.15	31.15	60.65	0.16	2.5	81.45	60.63	0.17	2.22	248.36	83.89
MT2	Muck tuff 2	sanidine	0.00191	0.25	12 of 12	60.89	0.2	30.31	60.91	0.19	1.06	100	60.92	0.4	3.86	144.31	129.15
MT2	Muck tuff 2	sanidine	0.001956	0.3	0.9-10	60.65	0.23	66.03	60.74	0.21	0.78	100	60.56	0.24	0.64	299.54	11.13
MT2	Muck tuff 2	sanidine	0.001956	0.3	1.7-10	60.55	0.2	31.9	60.49	0.2	1.52	100	60.51	0.49	1.57	289.58	66.64
MT2	Muck tuff 2	sanidine	0.001956	0.3	1.0-10	60.69	0.24	33.31	60.58	0.25	1.33	100	60.83	0.45	3.56	264.97	62.71
MT2	Muck Tuff 2	sanidine	0.001956	0.3	2.1-10	60.35	0.2	39	60.61	0.21	0.29	57.94	60.55	0.26	0.44	314.33	32.42
MT2	Muck Tuff 2	sanidine	0.002653	0.3	12 of 20	60.51	0.18	37.96	60.53	0.18	3.27	79.78	60.48	0.2	3.94	291.23	101.82
MT2	Weighted Mean Age	sanidine							60.65	0.07	0.75						
MT3	Muck Tuff 3	sanidine	0.001947	0.25	13 of 14	60.39	0.16	21.59	60.51	0.16	3.35	88.22	60.47	0.18	2	240.96	59.56
MT3	Muck Tuff 3	sanidine	0.001901	0.25	11 of 11	60.48	0.16	21.2	60.42	0.16	0.86	100	60.52	0.22	0.81	194.31	81.32
MT3	Muck Tuff 3	sanidine	0.001953	0.3	3.6-10	59.71	0.0559	25.33	60.36	0.19	1.54	59.41	60.34	0.3	2.24	323.61	129.45
MT3	Muck Tuff 3	sanidine	0.001953	0.3	1.6-fuse	60.17	0.19	27.11	60.2	0.19	0.91	100	59.98	0.21	2.5	318.53	23.99
MT3	Muck Tuff 3	sanidine	0.001953	0.3	1.7-4.5	60.33	0.19	27.62	60.36	0.2	1.9	100	60.44	0.24	2.76	291.21	35.5
MT3	Muck tuff 3	sanidine	0.001953	0.3	2.3-10	60.69	0.19	23.71	60.67	0.19	0.44	91.82	60.61	0.22	0.7	309.88	39.07
MT3	Muck tuff 3	sanidine	0.001953	0.3	1.7-fuse	60.5	0.19	39.82	60.52	0.19	1.02	100	60.53	0.21	1.12	309.23	46.92
MT3	Weighted Mean Age	sanidine							60.44	0.07	0.12						
SR215	*upper basalt, Rum*	*wr lch*	*0.002676*	*0.3*	*21.9-26.2*	*62.08*	*0.19*	*0.15*	*60.54*	*0.21*	*3.29*	*54.47*	*0.28*	*0.82*	*5.11*	*232.1*	*133.36*
SR252	basalt middle, Canna	wr core	0.00271	0.3	17.0-50.0	60.09	0.33	0.34	59.96	0.24	1.33	83.61	60.45	0.52	1.2	288.72	5.6
SR215 + 252	Weighted Mean Age								60	0.23	2.9						
SR539	*Western granophyre*	*hornblende*	*0.000935*	*0.3*	*4 of 7*	*73.11*	*0.29*	*0.92*	*73.53*	*2.52*	*401.96*	*85.27*	*66.95*	*5.96*	*688.38*	*400.13*	*219.85*
SR539	Western granophyre	hornblende	0.000933	0.3	4.0-10.0	64.75	0.27	1.33	61.32	0.4	2.54	50.35	62.12	1.11	3.22	272.59	27.99
SR539	*Western granophyre*	*hornblende*	*0.0009336*	*0.3*	*3.6-fuse*	*63.93*	*0.24*	*2.43*	*60.8*	*0.53*	*5.55*	*44.88*	*63.17*	*1.23*	*2.68*	*255.1*	*19.26*
SR539	Weighted Mean Age	hornblende							61.13	0.32	4.1						
SR475	Western granophyre	biotite	0.000934	0.5	3 of 4	53.3	0.68	2.28	60.01	0.45	2.38	89.03	60.89	0.59	1.32	281.09	7.4
MKD1	*Muck Dyke*	*wr lch*	*0.002042*	*0.3*	*13.0-37.0*	*71.4*	*0.261*	*0.062108*	*66.04*	*0.83*	*113.43*	*97.44*	*59.58*	*1.59*	*43.24*	*344.2*	*11.52*
T752	*Muck Lava*	*wr core*	*0.002711*	*0.3*	*25.0-43.0*	*83.5*	*0.06*	*0.065*	*65.83*	*1.59*	*3.24*	*28.06*	*59.11*	*2.41*	*0.32*	*323.8*	*5.18*
T908	Eigg	wr core	0.002711	0.3	16.0-37.0	54.11	0.28	0.077	59.78	0.25	1.9	64.9	59.52	0.3	1.77	299.5	2.59
EG	*Sgurr of Eigg*	*glass*	*0.0009385*	*0.3*	*1.8-fuse*	*46.05*	*0.17*	*7.37*	*47.8*	*0.34*	*9.23*	*82.07*	*58.69*	*0.86*	*0.9*	*135.66*	*11.62*
EG	*Sgurr of Eigg*	*glass*	*0.0009385*	*0.3*	*2.1-fuse*	*48.36*	*0.18*	*7.75*	*50.39*	*0.59*	*20.9*	*68.46*	*58.75*	*0.59*	*1.37*	*81.04*	*14.32*
EG	Weighted Mean Age	glass							47.14	0.12	87.05						
EP	Sgurr of Eigg	sanidine	0.0009436	0.3	3.9-fuse	60.34	0.21	1.02	59.19	0.2	1.03	65.75	58.9	0.49	2.05	337.1	127.5
EP	Sgurr of Eigg	sanidine	0.0009436	0.3	2.1-fuse	58.48	0.24	1.89	58.53	0.23	1.14	100	58.22	0.42	2.12	311.19	65.93
EP	Sgurr of Eigg	sanidine	0.000942	0.3	2.2-fuse	58.54	0.19	5.27	58.56	0.19	1.2	100	58.48	0.24	1.33	321.23	40.29
EP	Sgurr of Eigg	sanidine	0.0009393	0.3	3.5-fuse	58.73	0.2	9.6	58.84	0.24	2.37	67.5	58.84	0.69	1.85	314.24	297.15
EP	Sgurr of Eigg	sanidine	0.0009393	0.3	1.6-fuse	58.2	0.25	7.99	58.17	0.24	0.82	100	58.13	0.32	0.85	292.67	39.03
EP	Sgurr of Eigg	sanidine	0.0009383	0.3	2.1-fuse	58.81	0.2	7.68	58.87	0.23	2.5	100	58.81	0.29	2.88	279.53	72.24
EP	Sgurr of Eigg	sanidine	0.0009418	0.3	1.2-fuse	58.91	0.22	8.05	58.91	0.22	0.4	100	58.95	0.25	0.62	291.91	19.68
EP	Sgurr of Eigg	sanidine	0.000942	0.3	2.3-fuse	58.63	0.19	6.86	58.67	0.19	1.26	100	58.54	0.27	1.82	306.08	63.35
EP	Sgurr of Eigg	sanidine	0.002647	0.3	17 of 17	58.68	0.17	9.48	58.67	0.18	3.4	98.06	58.64	0.18	3.8	294.81	8.06
EP	Weighted Mean Age	sanidine							58.73	0.08	1.95						

Table 4.1. $^{40}Ar/^{39}Ar$ age results for samples from the Small Isles. Results in italics failed the criteria of Pringle (1992). Weighted mean ages for the Muck Tuffs and the Sgurr of Eigg pitchstone are also included.

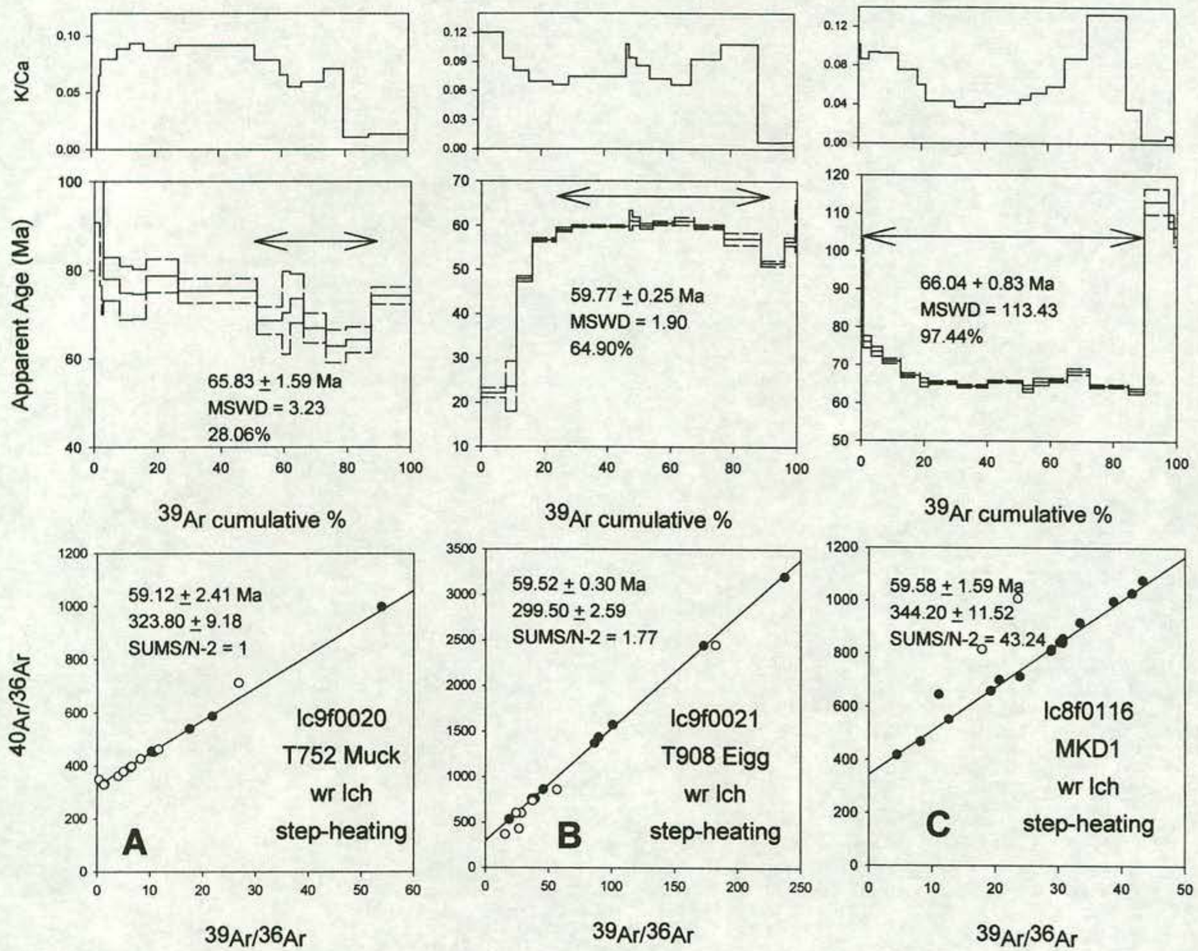


Figure 4.5. Whole rock age spectrum and isochron plots for sample T752 (lava from Muck), T908 (Lava from Eigg) and MKD1 (dyke Camas Mor, Muck). The non atmospheric isochron intercept shows the presence of excess argon in samples T752 and MKD1. MKD1 also had the characteristic saddle shaped age spectrum associated with excess argon. T908, from Eigg, has young ages at low temperature, which is characteristic of argon loss.

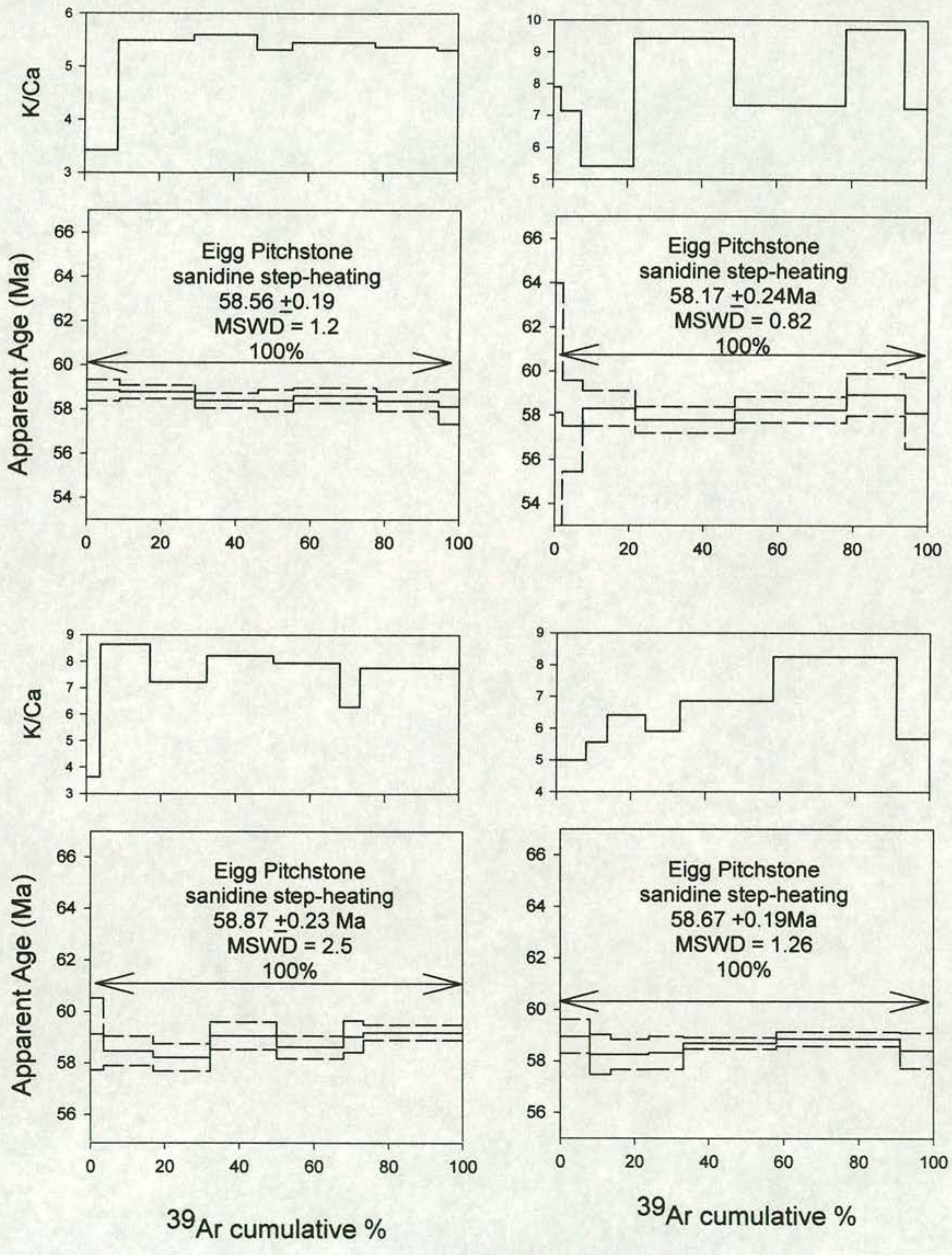


Figure 4.6. Four Sgurr of Eigg sanidine incremental-heating age spectra. The flat age plateaus show that the system has been closed since crystallisation.

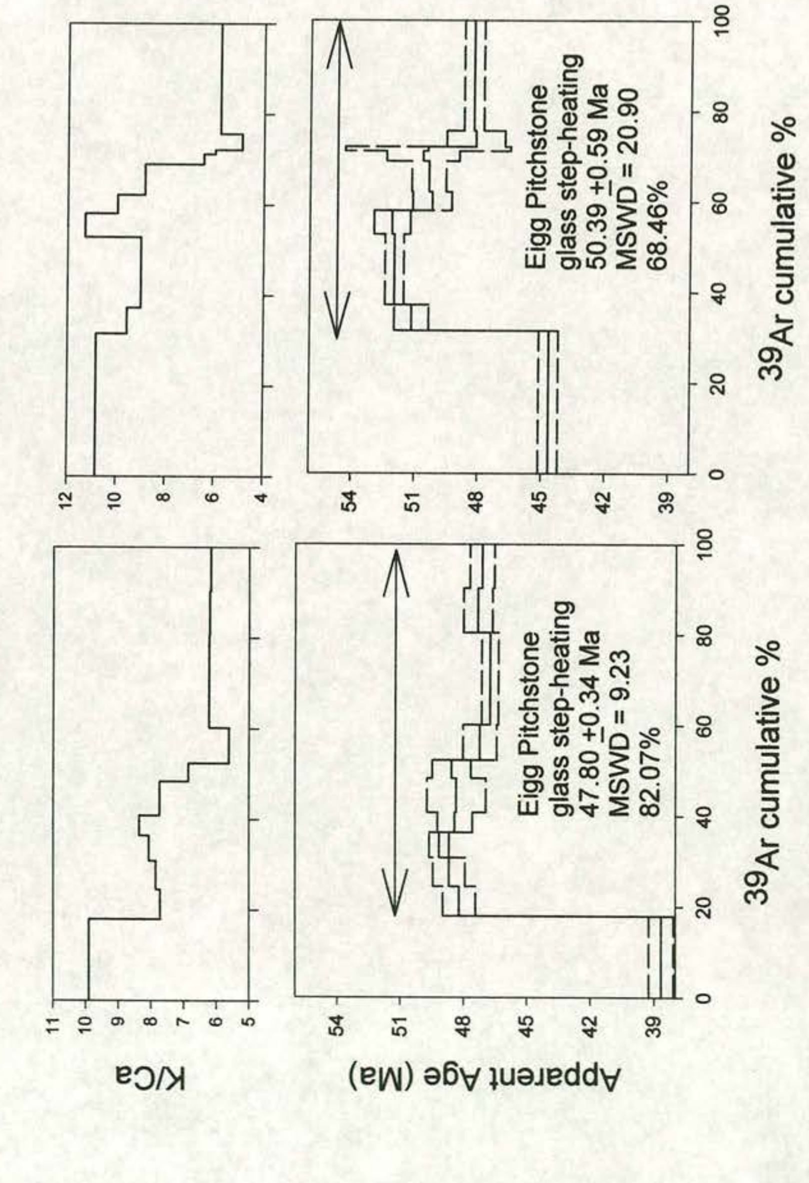


Figure 4.7. Incremental-heating age spectra for the glass from the Sgurr of Eigg pitchstone. The discordant plateau and young ages show that the system has been disturbed.

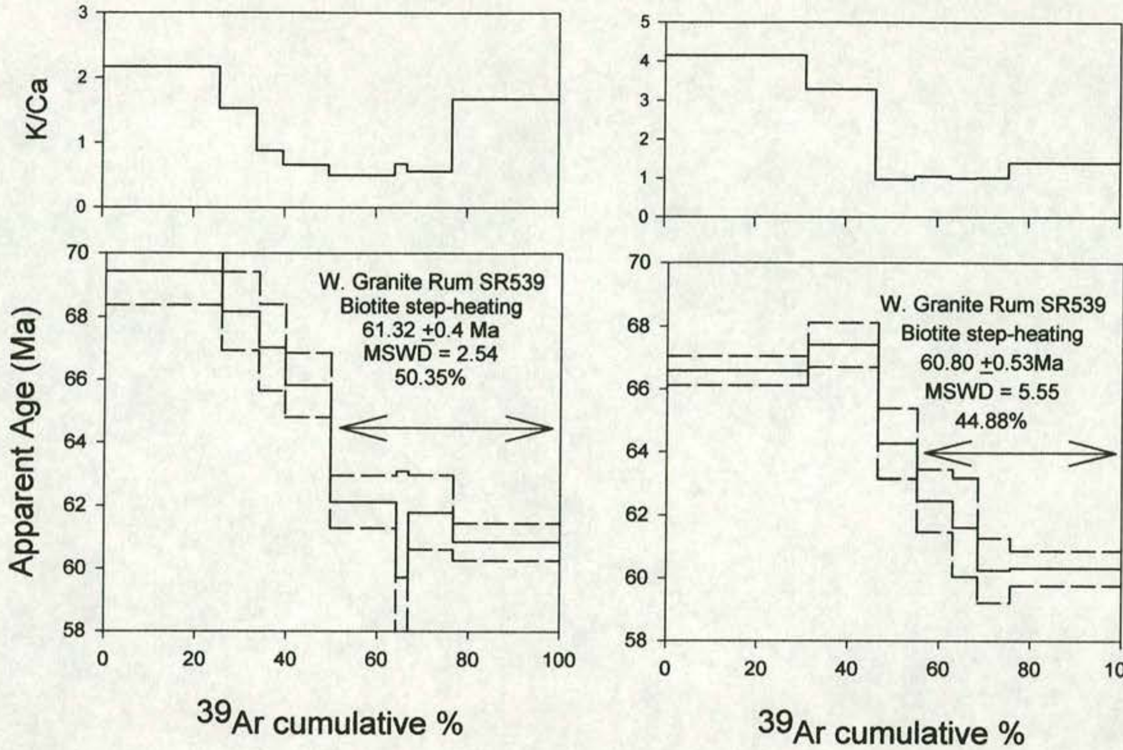


Figure 4.8. Two age spectra for biotites from SR539 that were analysed by individual crystal incremental-heating. The stepwise decreasing plateau associated with argon recoil can be seen.

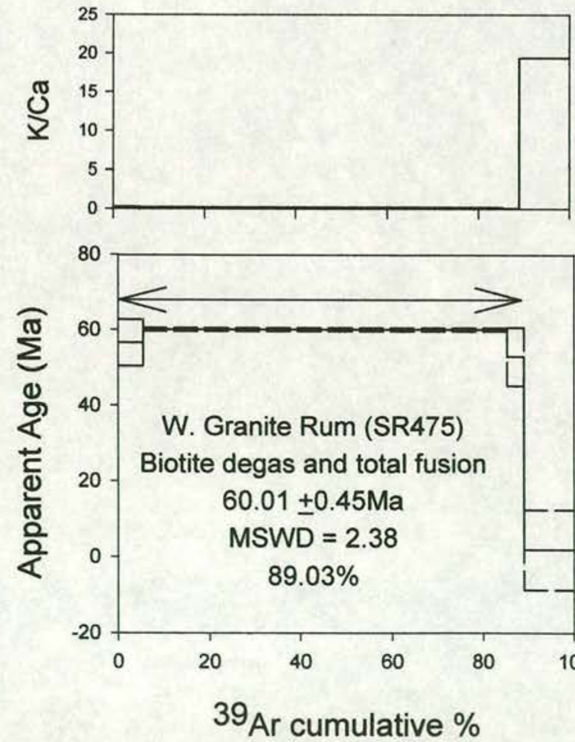


Figure 4.9. The age spectrum for sample SR475 analysed using the degassing and total-fusion method.

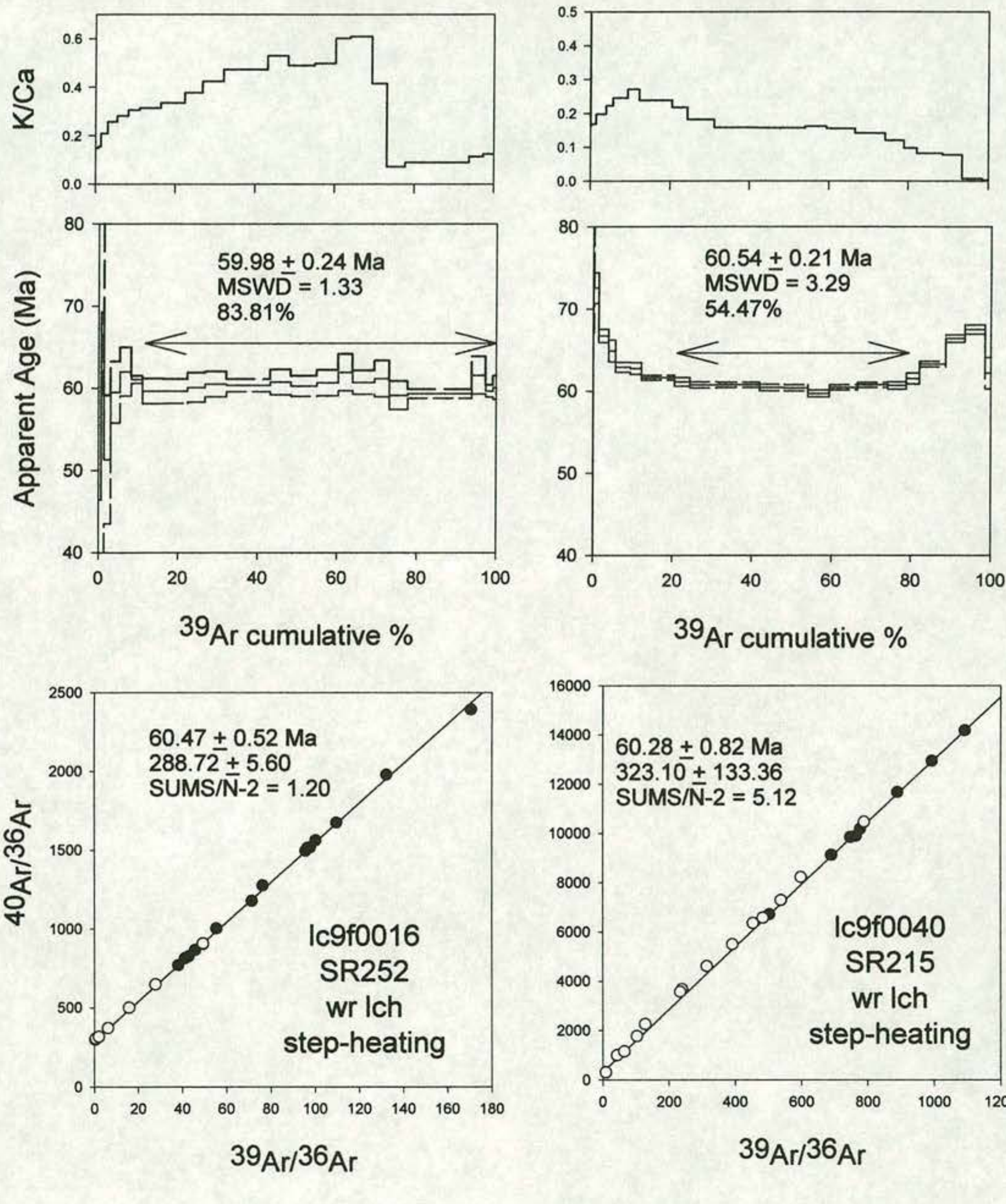


Figure 4.10. Whole rock incremental-heating experiments for two samples, SR252 (Canna lava) and SR215 (Rum lava). Age spectra and isochrons are shown for both samples.

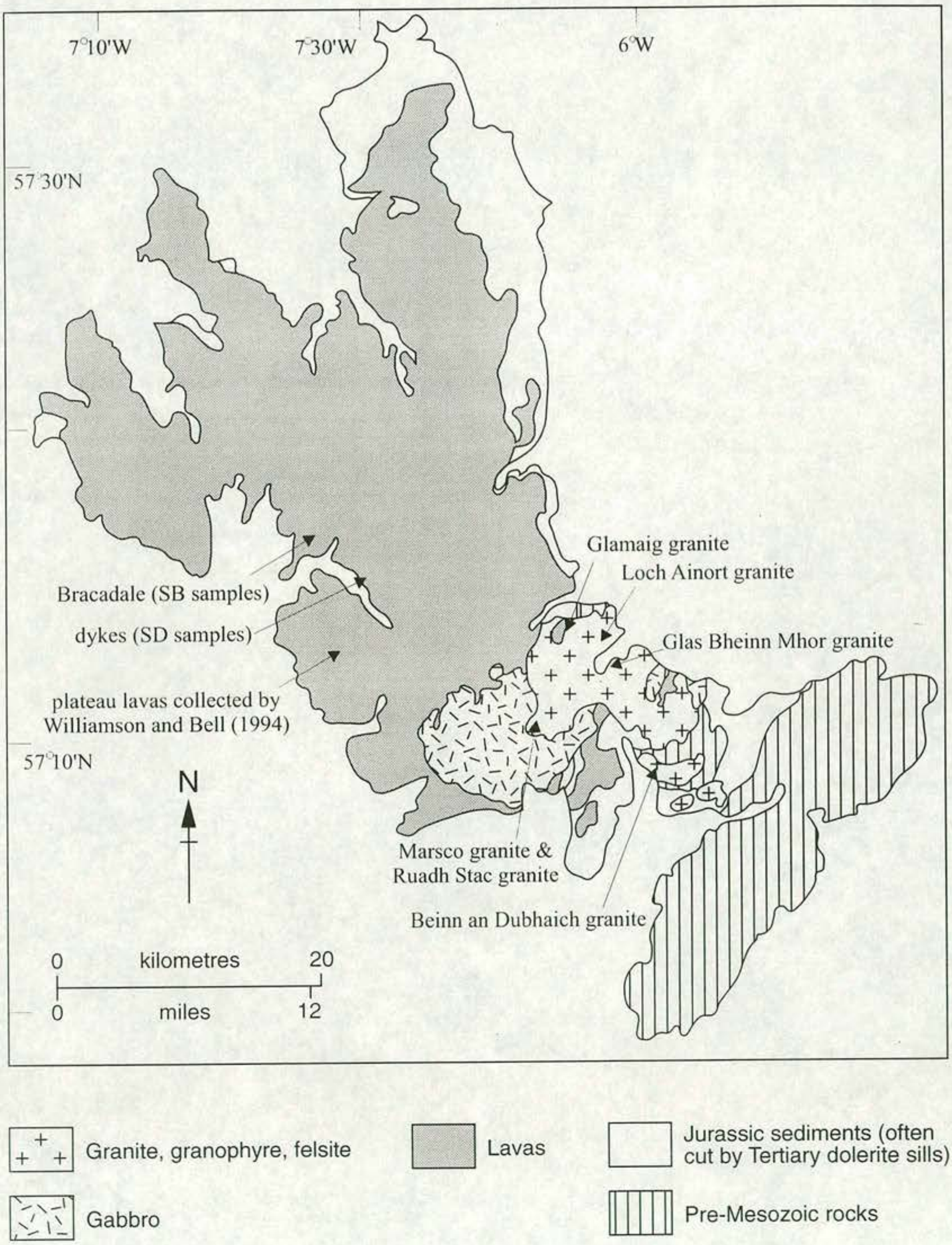


Figure 4.11. A simplified geological map of Skye, redrawn from Emeleus and Gyopari (1992). The location of the granites, dykes and lava flows sampled are shown.

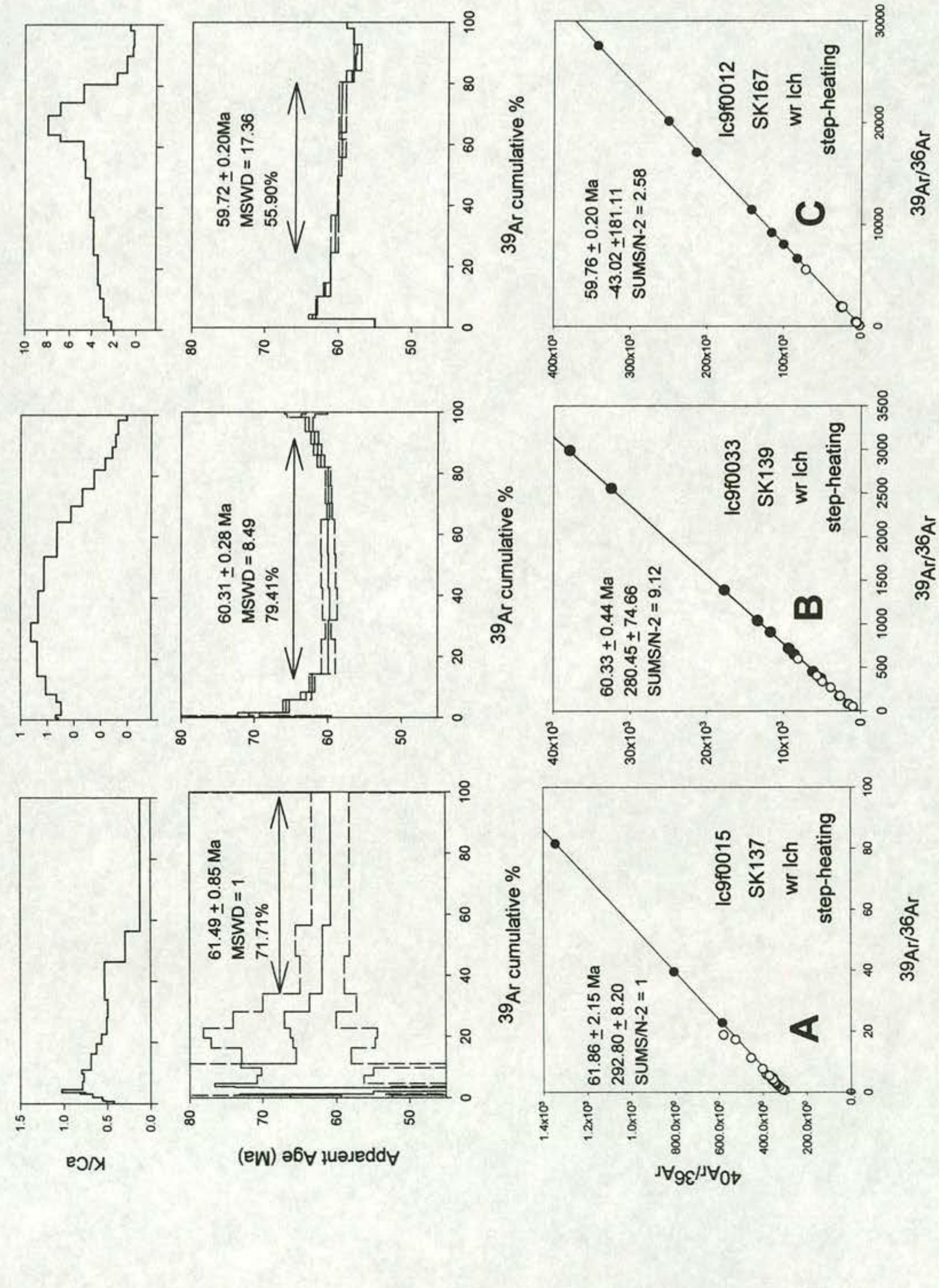


Figure 4.12. Whole rock incremental-heating experiments for three lava flows from Skye, SK139, SK137 and SK139. Isochron plots and age spectra are shown for each sample.

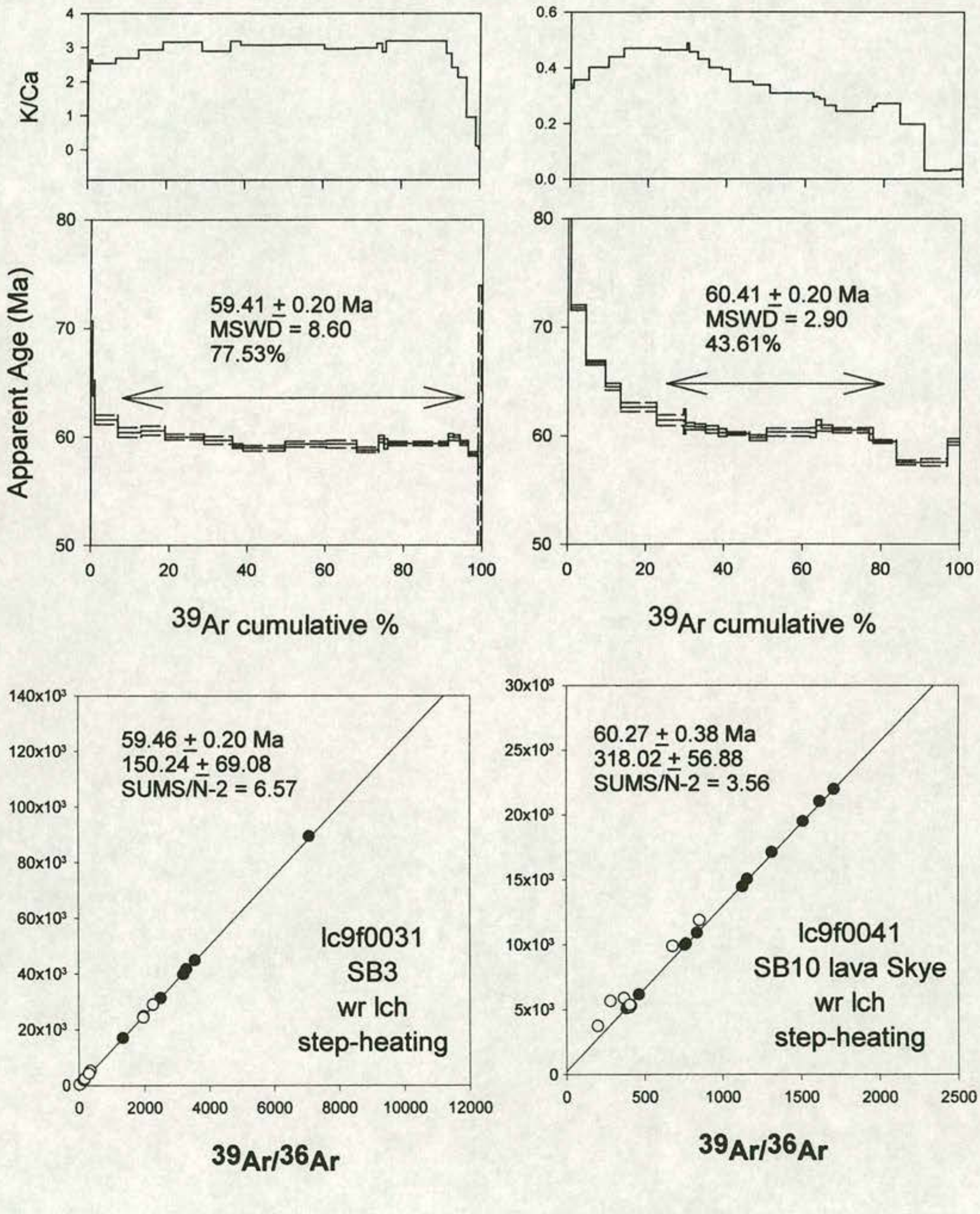


Figure 4.13. Whole rock (leached) incremental-heating experiments on two samples from Bracadale, Skye (SB3 and SB10). Age spectra and isochrons for both samples are shown.

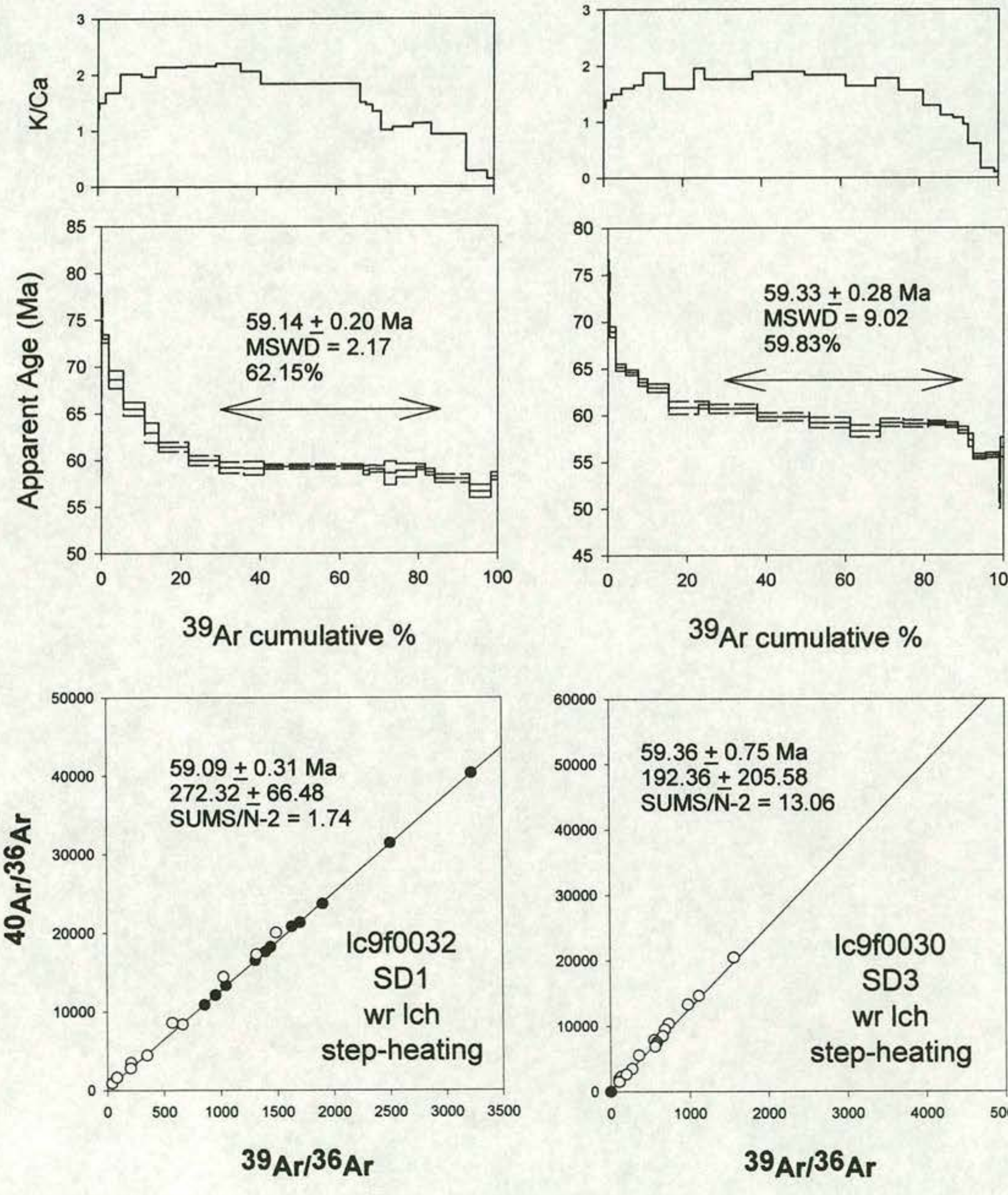


Figure 4.14. Whole rock (leached) incremental-heating experiments on two dyke samples from Skye (SD1 an SD3).

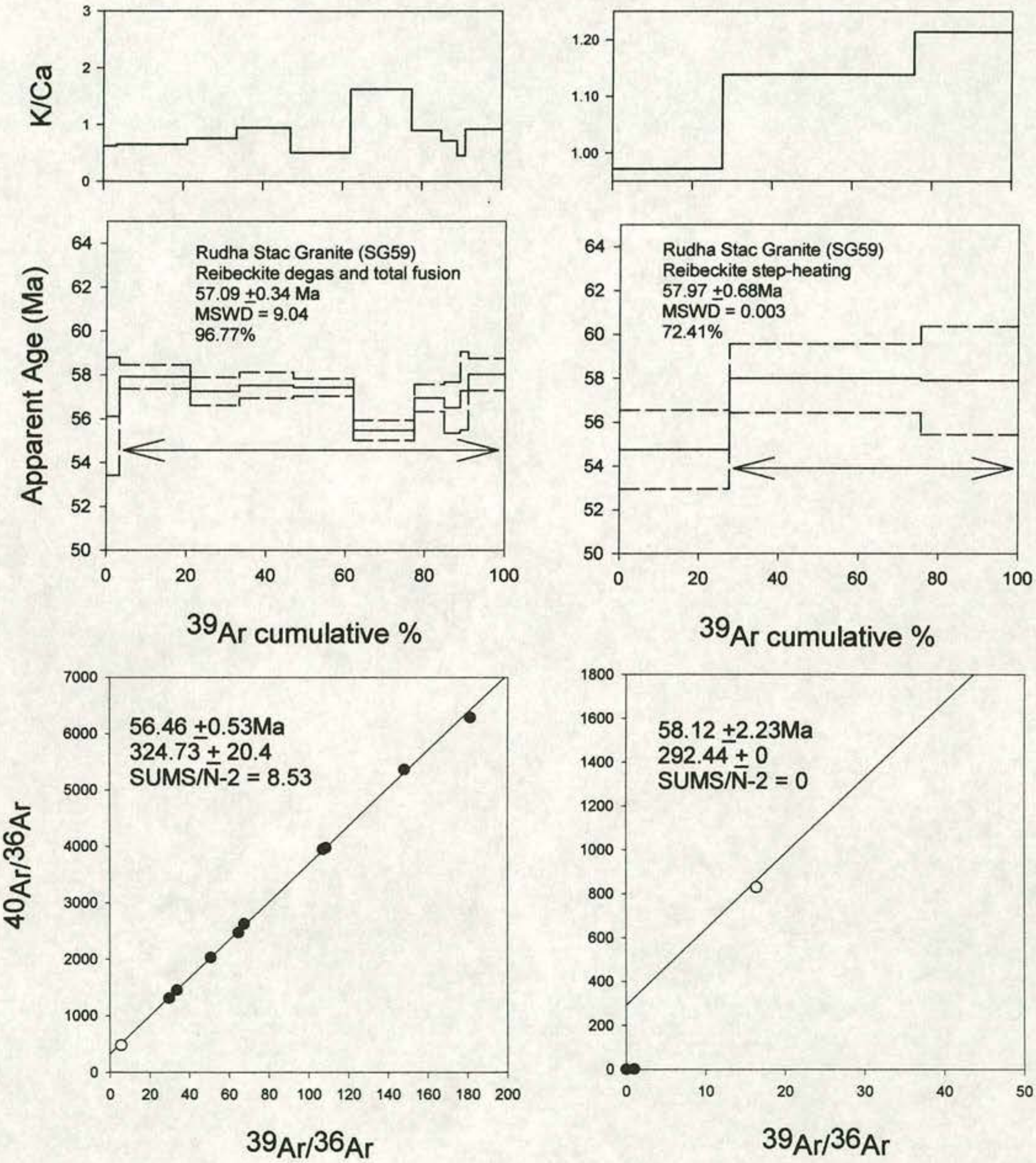


Figure 4.15. An incremental-heating and a degassing and total-fusion experiment on riebeckite crystals from the Rudha Stac granite, Skye.

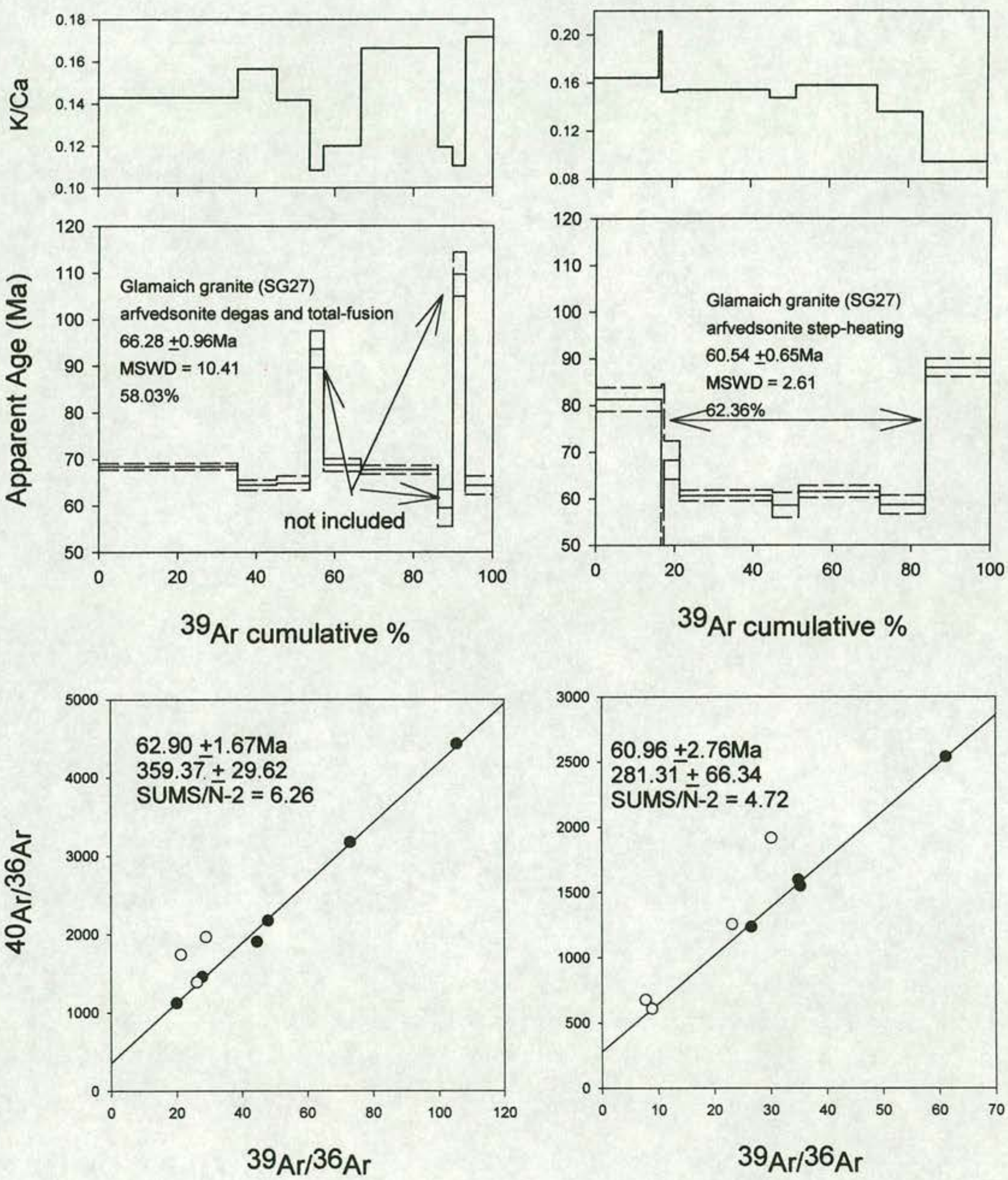


Figure 4.16. Single crystal incremental-heating and degassing and total-fusion analysis on arfvedsonite from the Glamaig granite, Skye. Age spectra and isochrons are shown for both experiments.

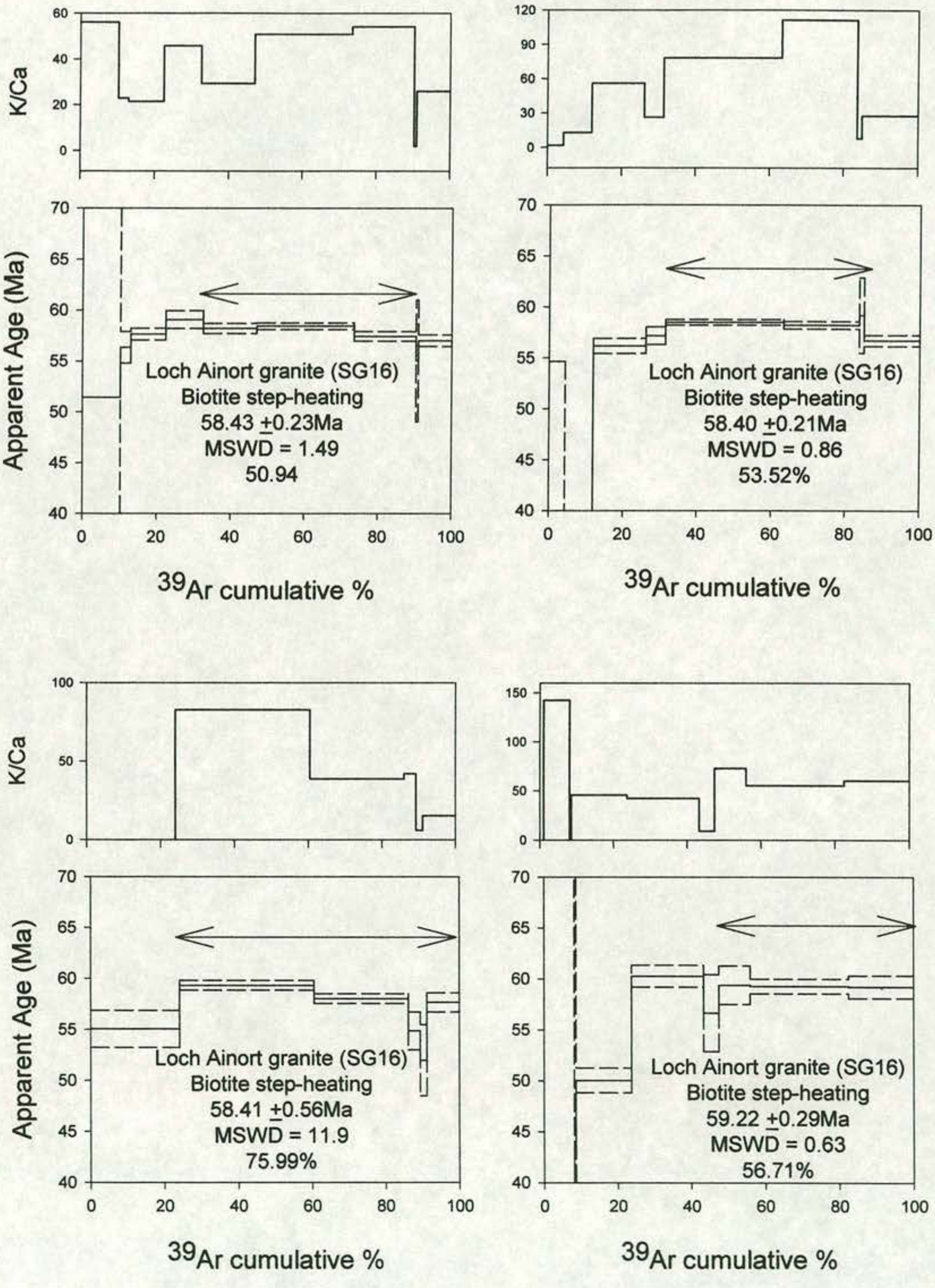
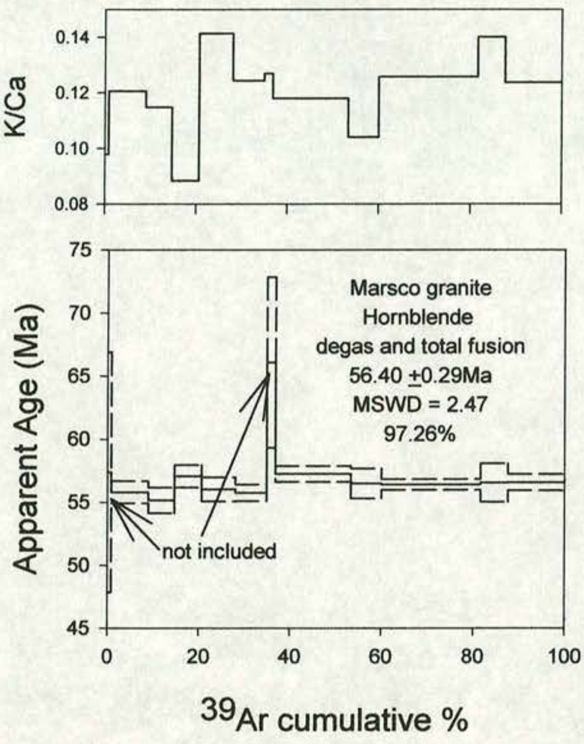


Figure 4.17. Single crystal laser incremental-heating experiments on biotite crystals from the Loch Ainort granite, Skye.



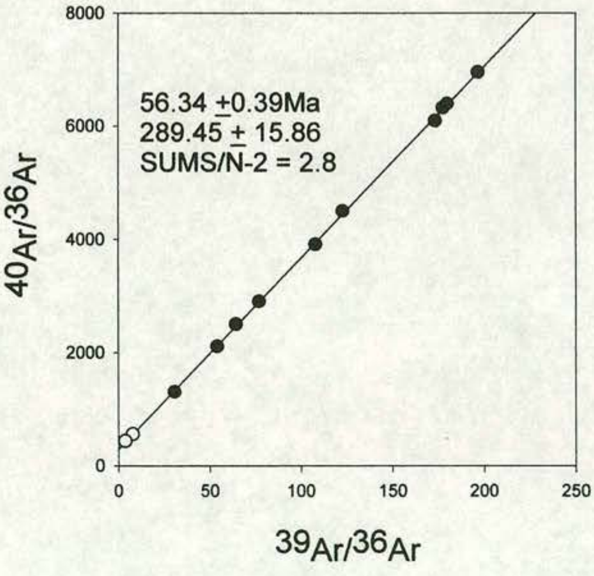


Figure 4.18. Combined degassing and total-fusion analysis on nine hornblende crystals from the Marsco granite. The age spectrum and isochron plots are shown.

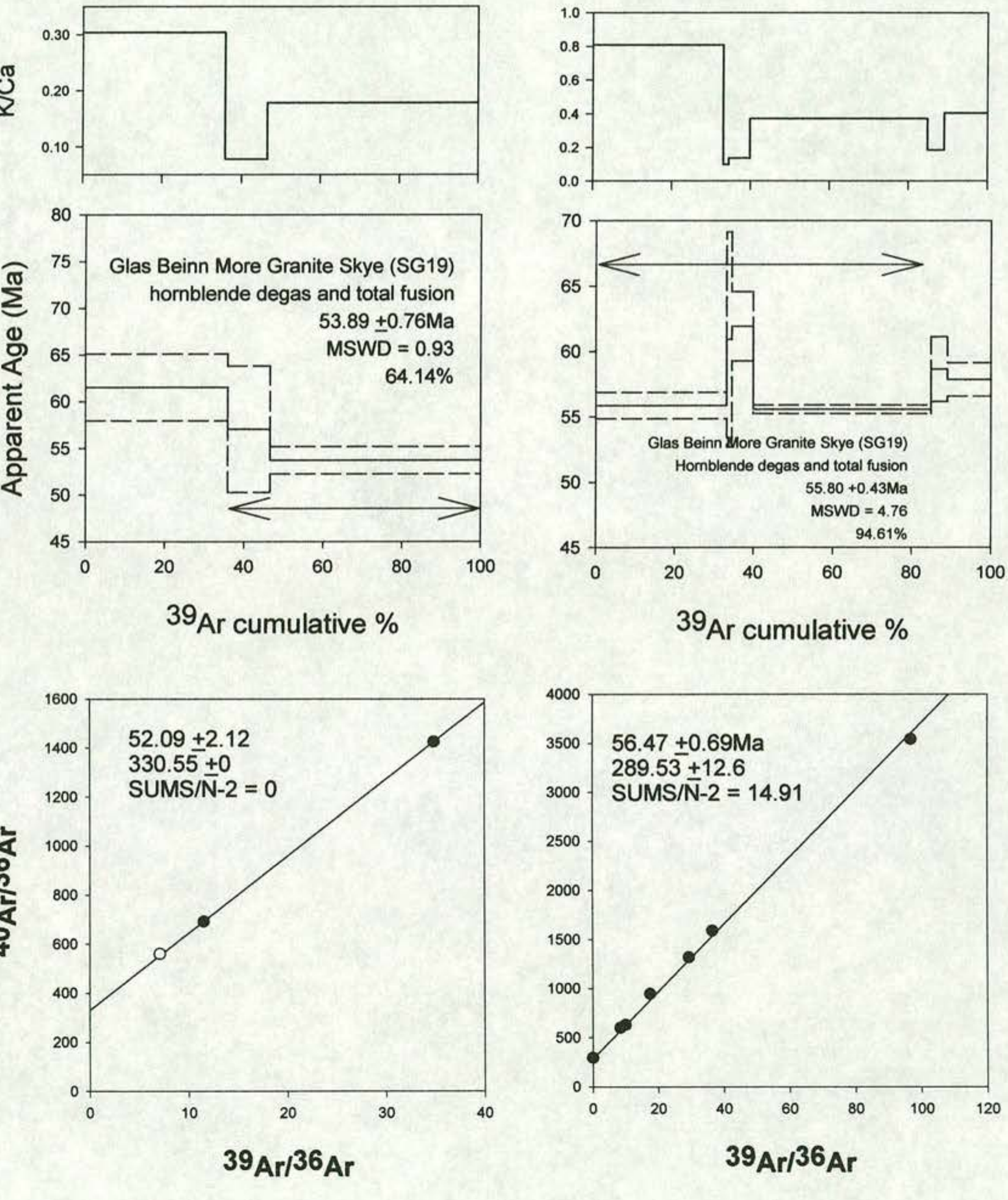


Figure 4.19. Single crystal incremental-heating analysis and degassing and total-fusion experiments on hornblende from the Glas Bheinn Mor granite, Skye. Age spectra and isochron plots are shown for both types of experiment.

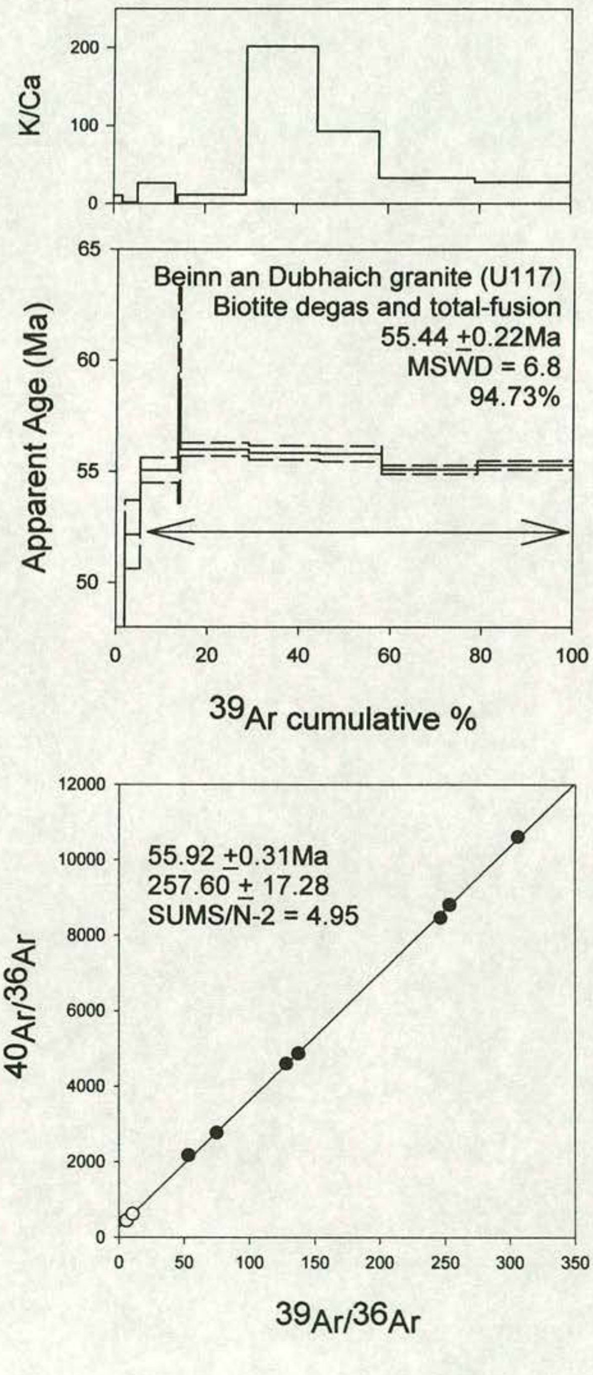


Figure 4.20. Degassing and total-fusions on biotite from the Beinn an Dubhaich granite, Skye.

Sample	Name	Material	J value	Sd J	Steps	TF age	Error	Total K/Ca	WMPA	Sd	MSWD	Cum. Ar%	Iso age	Error	Sums/n-2	Intercept	Error
SK137	basalt middle, Skye	wr core	0.002710	0.3	28.0-47.0	62.69	0.93	0.4	61.33	0.88	0.22	65.85	62.58	2.22	7.75	286.92	3.87
SK139	basalt middle, Skye	wr lch	0.002688	0.3	19.2-28.5	60.93	0.21	0.5	61.31	0.28	8.49	799.41	60.32	0.44	9.12	280.45	74.66
SK167	basalt middle, Skye	wr core	0.002709	0.3	18.0-25.0	60.62	0.19	5.8	60.45	0.21	5.18	77.25	60.24	0.25	2.97	224.02	80.64
SB3	basalt middle, Skye	wr lch	0.002682	0.3	19.7-30.5	59.7	0.19	2.9	59.41	0.2	8.6	77.53	59.46	0.2	6.57	150.24	69.08
SB10	*basalt middle, Skye*	*wr lch*	*0.002679*	*0.3*	*18.5-27.0*	*61.23*	*0.19*	*0.3*	*60.41*	*0.2*	*2.9*	*43.61*	*60.27*	*0.38*	*3.56*	*318.02*	*56.88*
Lavas	Weighted Mean Age								59.83	0.12	2.9						
SD3	dyke, Skye	wr lch	0.002672	0.3	21.5-29.2	60.07	0.19	1.6	59.34	0.28	9.02	59.83	59.36	0.75	13.06	192.36	205.58
SD1	dyke, Skye	wr lch	0.002685	0.3	20.0-30.0	60.21	0.19	1.6	59.14	0.2	2.17	62.15	59.09	0.31	1.74	272.12	66.48
SD1 & 3	Weighted Mean Age								59.2	0.16	0.3						
U117	Beinn an Dubhaich granite	biotite	0.000935	0.3	7 of 9	55.17	0.18	60.7	55.44	0.22	6.8	94.73	55.92	0.31	4.95	257.6	17.28
SG27	*Glamaich granite*	*arfvedsonite*	*0.000928*	*0.5*	*6 of 9*	*69.29*	*0.41*	*0.1*	*66.28*	*0.96*	*10.41*	*58.03*	*62.9*	*1.67*	*6.26*	*359.37*	*29.62*
SG27	Glamaich granite	arfvedsonite	0.000932	0.3	2.2-3.4	68.73	0.43	0.1	60.54	0.65	2.61	62.36	60.96	2.76	4.72	281.31	66.34
SG19	*Glas Beinn More granite*	*hornblende*	*0.000934*	*0.5*	*2 of 3*	*56.9*	*0.88*	*0.2*	*53.89*	*0.76*	*0.93*	*64.14*	*52.09*	*2.12*	*0*	*330.55*	*0*
SG19	Glas Beinn More granite	hornblende	0.000934	0.5	6 of 6	56.48	0.36	0.5	55.8	0.43	4.76	94.61	56.47	0.69	14.91	289.53	12.6
SG16	Loch Ainort granite	biotite	0.000934	0.3	1.6-2.2	57.3	2	42.2	58.43	0.23	1.49	50.94	58.07	0.44	1.42	313.35	18.44
SG16	*Loch Ainort granite*	*biotite*	*0.000934*	*0.3*	*2.1-10*	*68.13*	*0.38*	*13.1*	*74.34*	*1.63*	*73.96*	*87.76*	*77.95*	*3.67*	*112.72*	*251.86*	*34.82*
SG16	Loch Ainort granite	biotite	0.000935	0.3	2.8-4	48.298	3.47	62.3	58.4	0.21	0.86	53.52	58.19	0.51	0.79	311.67	28.87
SG16	*Loch Ainort granite*	*biotite*	*0.000935*	*0.3*	*1.8-fuse*	*47.62*	*0.18*	*25.7*	*52.88*	*1.11*	*97.92*	*68.56*	*60.4*	*0.73*	*4*	*78*	*19.94*
SG16	Loch Ainort granite	biotite	0.000935	0.03	2.0-fuse	57.56	0.3	-2.4	58.41	0.56	11.9	75.99	59.73	0.67	6.68	235.21	22.81
SG16	*Loch Ainort granite*	*biotite*	*0.000934*	*0.3*	*1.5-fuse*	*60.07*	*0.75*	*36.1*	*65.14*	*0.85*	*6.26*	*84.24*	*66.12*	*1.89*	*11.17*	*281.77*	*18.69*
SG16	Loch Ainort granite	biotite	0.000935	0.3	2.1-fuse	55.52	0.32	56.9	59.22	0.29	0.63	56.71	59.95	0.72	0.56	278.72	11.13
SG16	*Loch Ainort granite*	*biotite*	*0.000935*	*0.3*	*1.8-fuse*	*60.91*	*0.38*	*9.0*	*64.42*	*0.53*	*3.37*	*84.9*	*64.23*	*1.26*	*5.57*	*297.06*	*15.56*
SG16	Weighted Mean Age								58.58	0.13	2.04						
SG32	Marsco granite	hornblende	0.000938	0.4	10 of 12	56.63	0.26	0.1	56.4	0.29	2.47	97.26	56.34	0.39	2.8	289.45	15.86
SG59	Rudha Stac granite	riebeckite	0.000948	0.3	2.2-fuse	57.08	0.57	1.1	57.97	0.68	0.003	72.41	58.12	2.23	0	292.44	0
SG59	Rudha Stac granite	riebeckite	0.000945	0.3	9 of 10	57.14	0.2	0.9	57.09	0.34	9.04	96.77	56.46	0.53	8.53	324.73	20.14
SG59	Weighted Mean Age								57.27	0.3	1.34						

Table 4.2. $^{40}Ar/^{39}Ar$ dating results on samples from Skye. Results in italics failed the acceptance criteria of Pringle (1992). Weighted mean ages for multiple analyses are also shown.

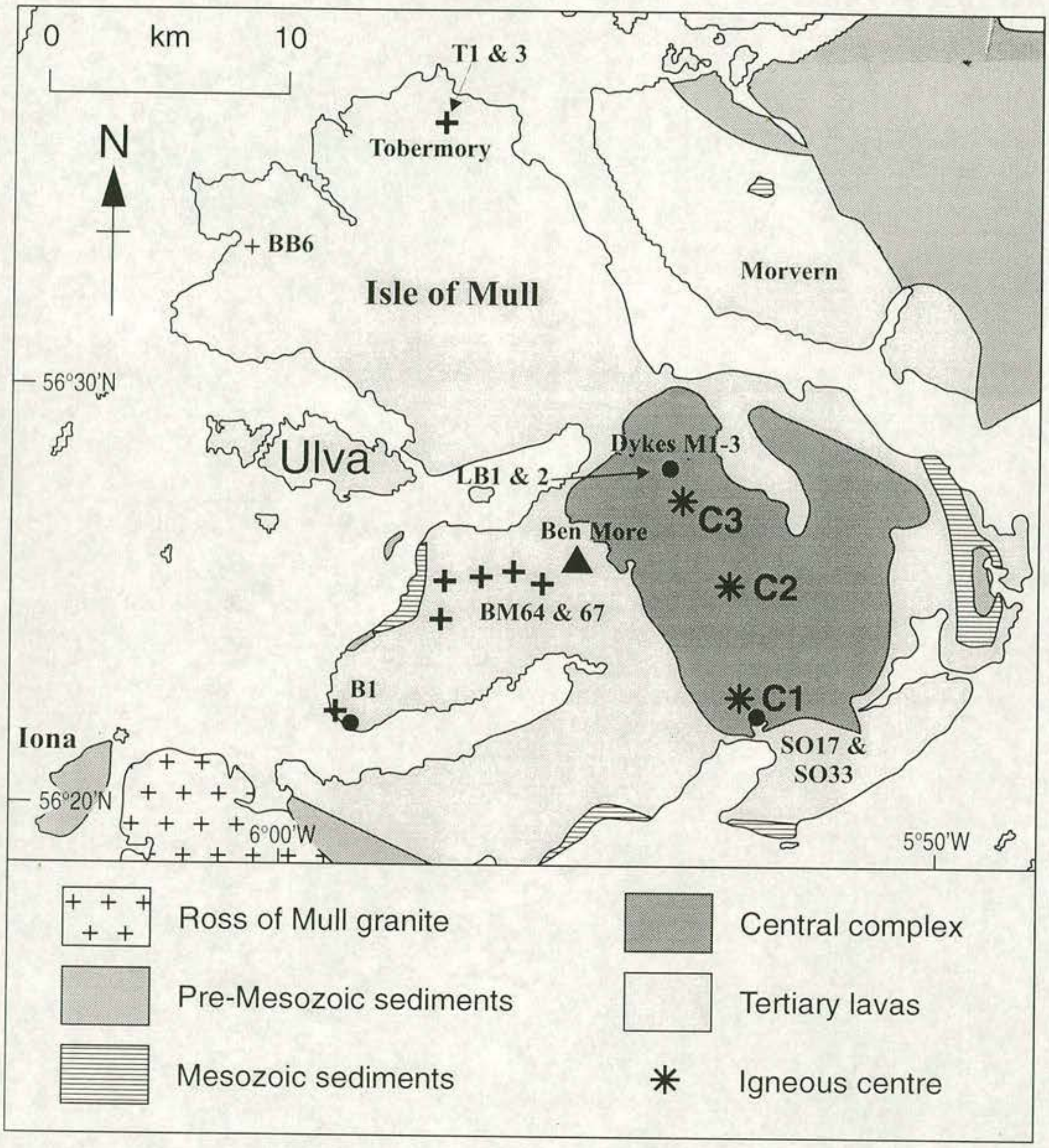


Figure 4.21. A simplified geological map of Mull, redrawn from Emeleus and Gyopari (1992). The position of the sample sites and the three igneous centres are shown.

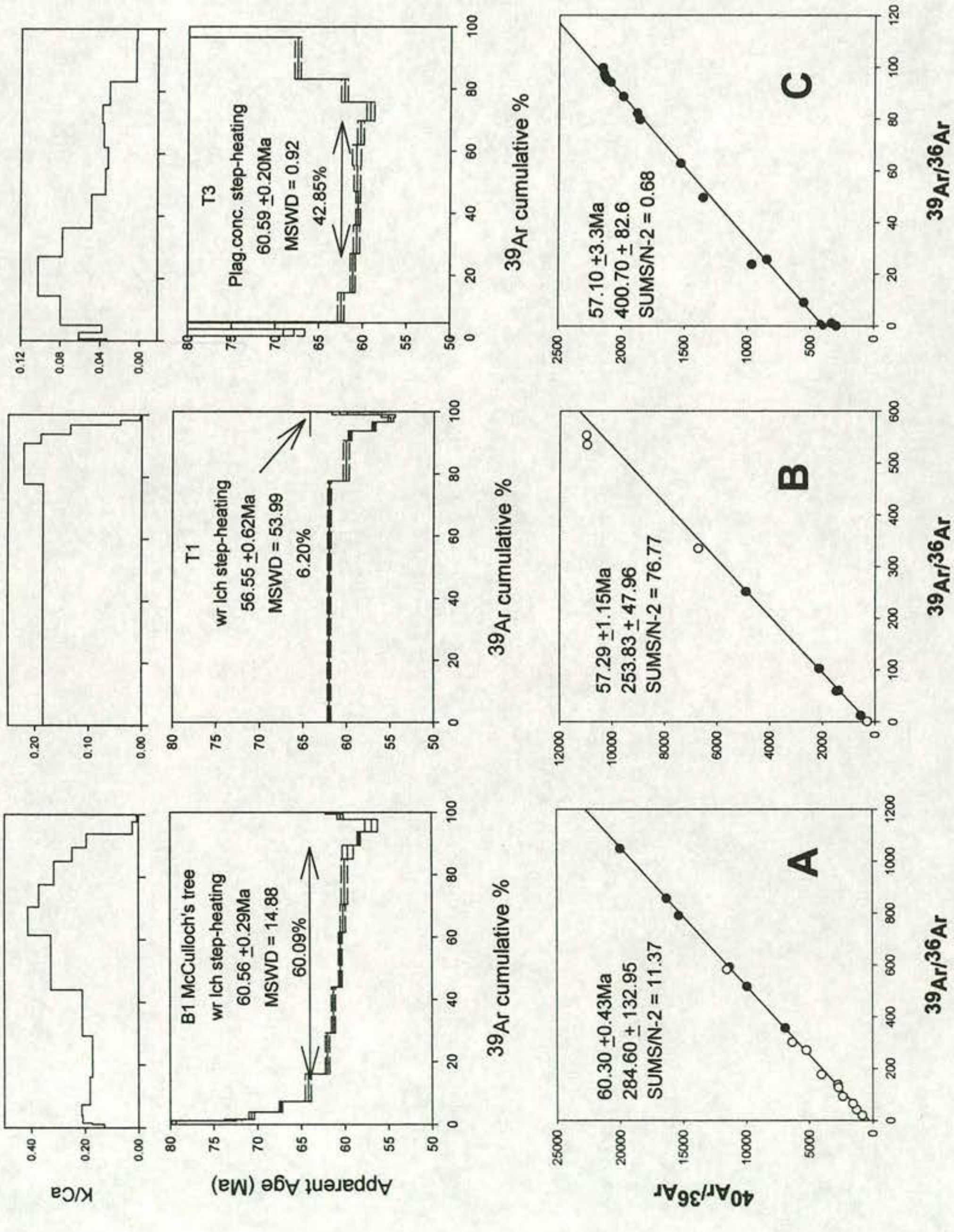


Figure 4.22. Three whole rock incremental-heating experiments on lava samples from Mull (B1, T1 and T3). Age spectra and isochron plots are shown for all three experiments.

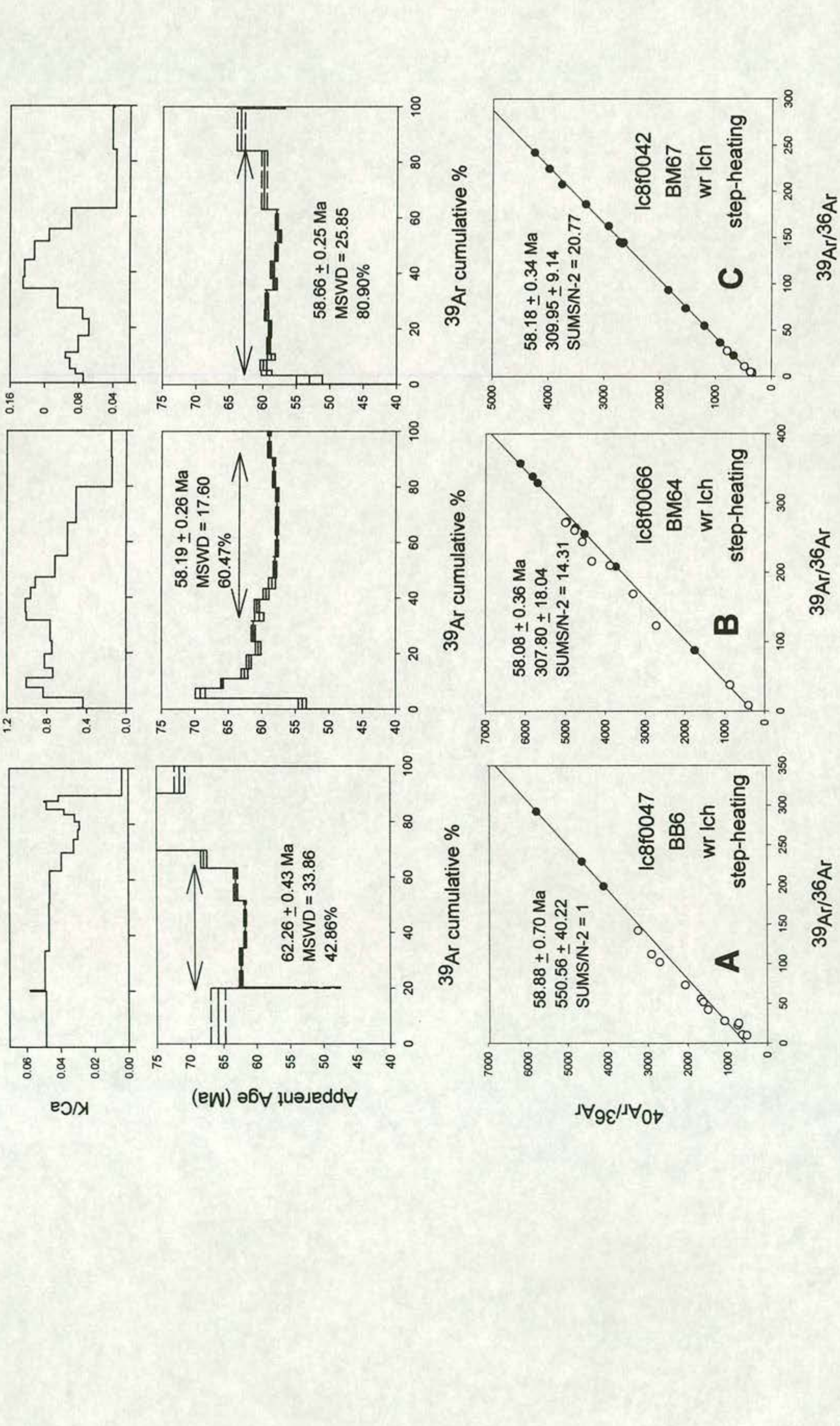


Figure 4.23. Three whole rock incremental-heating experiments on a basal lava (BB6) and two lava flows from a height of ~700m in the Ben More succession in Mull (BM64 & BM67). Age spectra and isochron plots are shown for all three experiments.

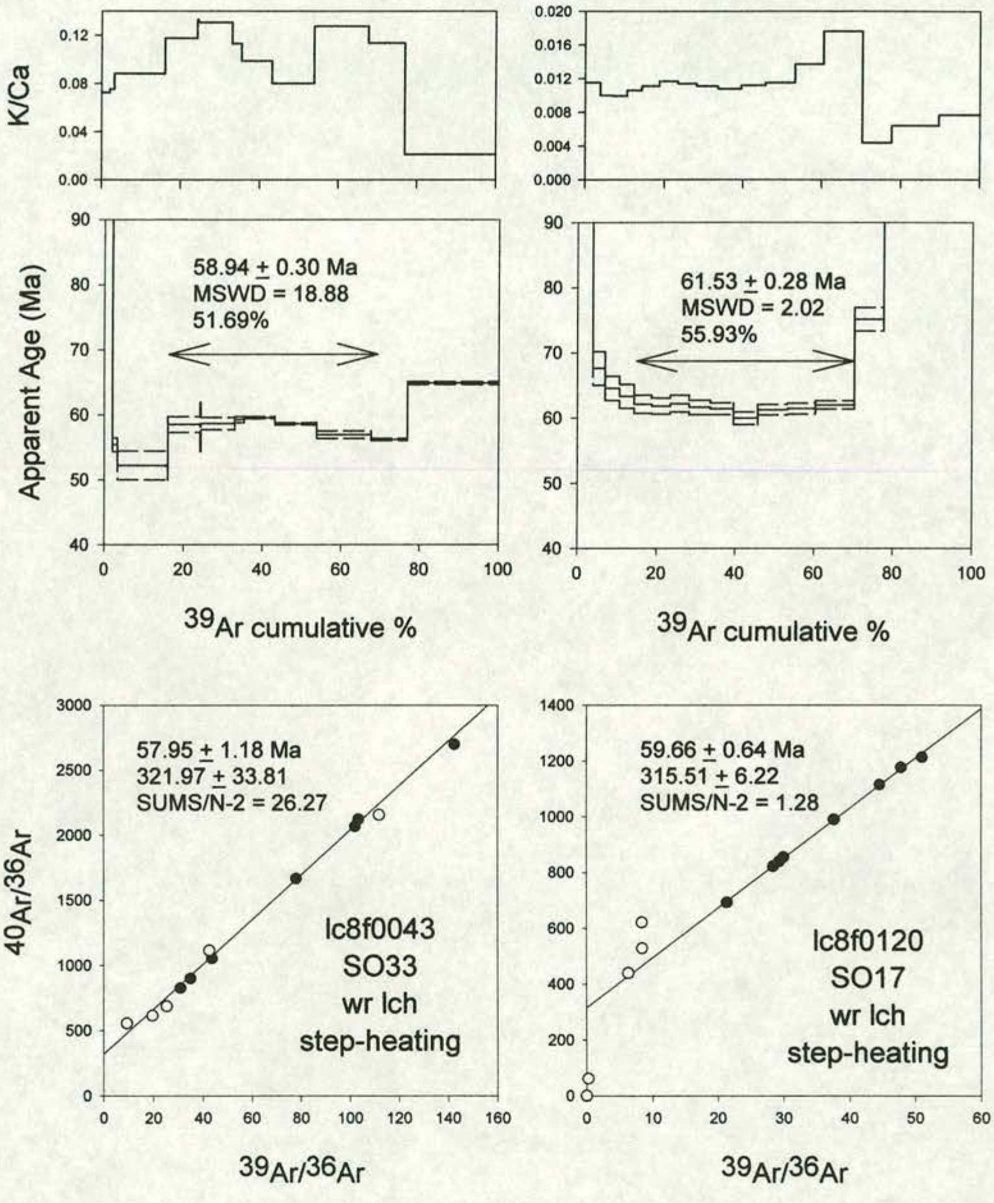


Figure 4.24. Two whole rock incremental-heating experiments on samples SO17 and SO33. These samples are lava flows with normal magnetic polarity from within Centre 1, Mull.

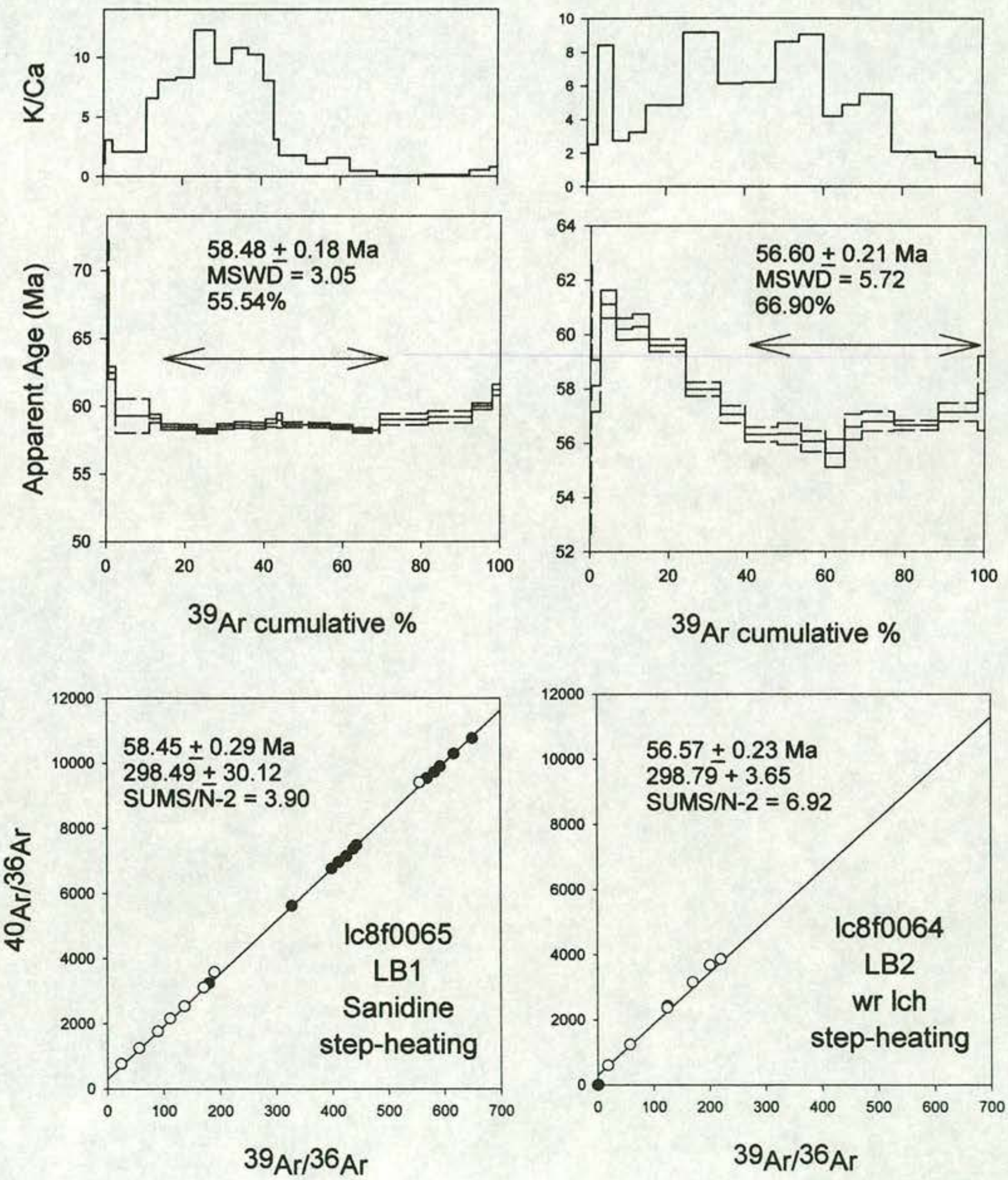


Figure 4.25. Whole rock and sanidine incremental-heating experiments on samples from the Loch Ba ring dyke, Mull. Age spectra and isochron plots are shown for both experiments.

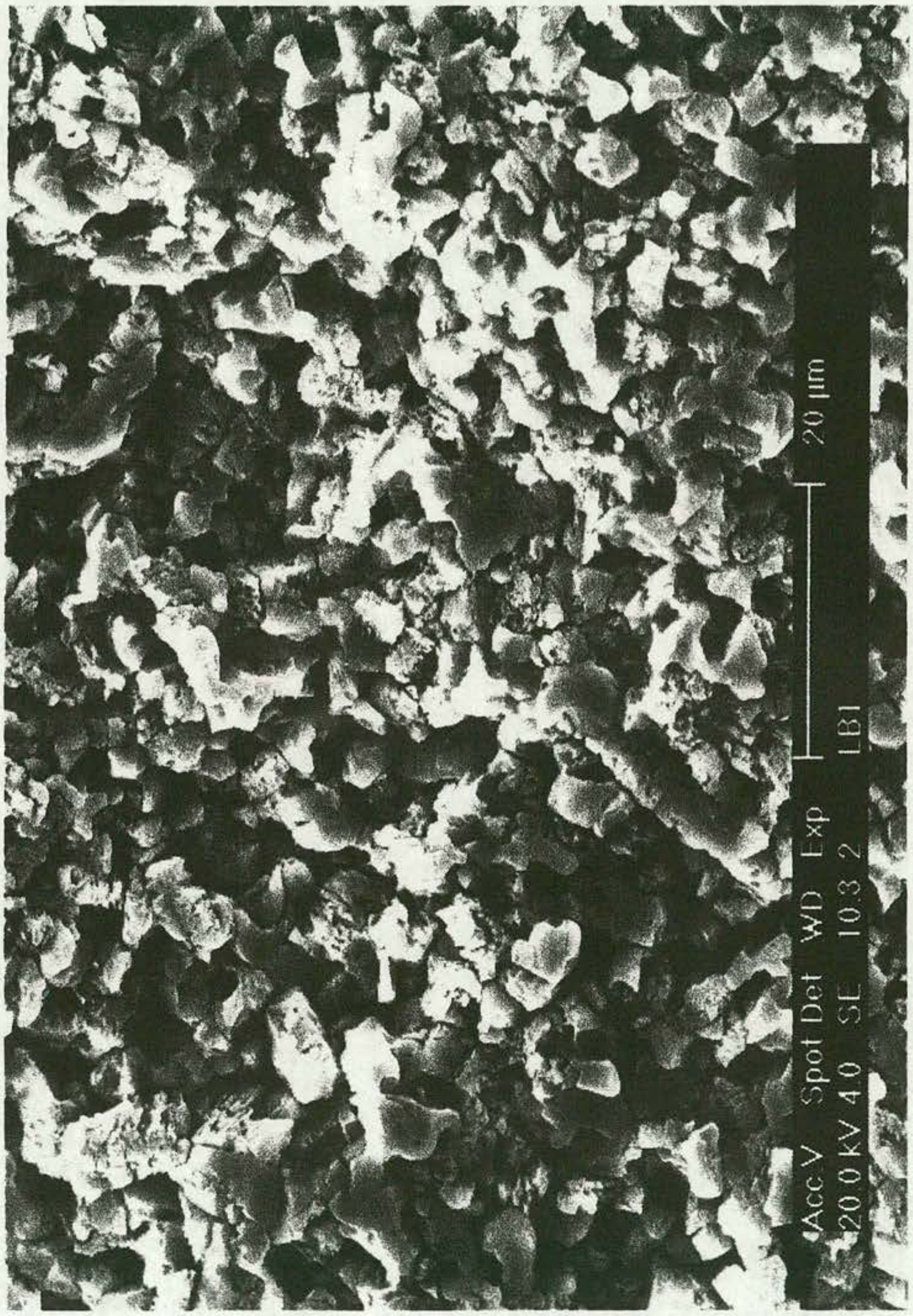


Figure 4.26. Scanning electron microscope image of the whole rock sample from the Loch Ba ring dyke showing a groundmass of quartz and feldspar.

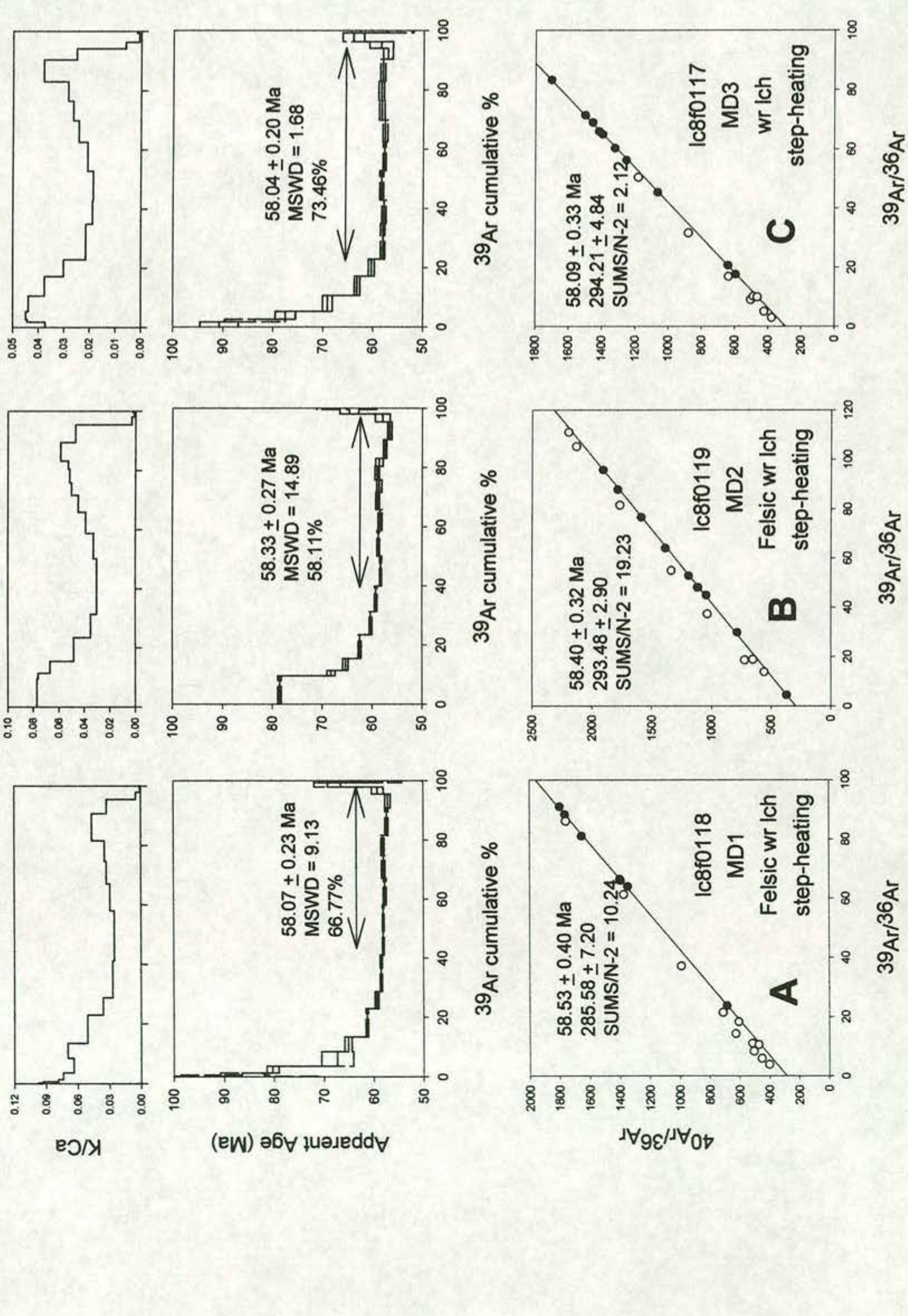


Figure 4.27. Two whole rock incremental-heating experiments and one felsic concentrate incremental-heating experiment on samples MD1-3. MD1-3 are dykes that cross-cut the Loch Ba ring dyke. Age spectra and isochron plots for all three experiments are shown.

Sample	Name	Material	J value	Sd J	Steps	TF age	Error	Total K/Ca	WMPA	Sd	MSWD	Cum. Ar%	Iso age	Error	Sums/n-2	Intercept	Error
B1	Lower lavas	wr lch	0.001817	0.3	24.0-31.0	61.54	0.187	0.249	60.56	0.29	14.88	60.09	60.3	0.429	11.37	284.6	132.95
BB6	*Lower lavas*	*wr lch*	*0.001856*	*0.3*	*17.*-20.5*	*68.13*	*0.238*	*0.040*	*62.26*	*0.4295*	*33.875*	*42.86*	*58.88*	*0.698*	*0.626*	*550.56*	*40.22*
T1	*Tobermory lavas*	*wr lch*	*0.001756*	*0.3*	*32.5-50.0*	*61.36*	*0.198*	*0.183*	*56.55*	*0.62*	*53.99*	*6.2*	*57.29*	*1.15*	*76.77*	*253.83*	*47.96*
T3	*Tobermory lavas*	*plag conc*	*0.00179*	*0.3*	*24.0-32.0*	*63.82*	*0.206*	*0.048*	*60.59*	*0.195*	*0.922*	*42.85*	*57.095*	*3.3*	*0.68*	*400.699*	*82.6*
BM64	Ben More	wr lch	0.001993	0.3	23.5-43.0	59.58	0.18	0.616	58.19	0.263	17.6	60.47	58.08	0.364	14.31	307.8	18.04
BM67	Ben More	wr lch	0.002009	0.25	17.0-37.0	59.46	0.16	0.078	58.66	0.25	25.85	80.895	58.18	0.34	20.77	309.95	9.14
BM64 & 67	Weighted Mean Age								58.38	0.19	1.45						
SO33	Central lavas	wr lch	0.001903	0.3	19.5-32.0	59.595	0.239	0.087	58.94	0.299	18.875	51.69	57.95	1.179	26.27	321.96	33.81
SO17	*Central lavas*	*wr lch*	*0.00188*	*0.3*	*17.0-32.0*	*78.06*	*0.3*	*0.010*	*61.54*	*0.28*	*2.02*	*55.93*	*59.66*	*0.64*	*1.28*	*315.5*	*6.22*
SO17 & 33	Weighted Mean Age								59.05	0.27	1.13						
LB1	Loch Ba ring dyke	sanidine	0.002034	0.3	18.0-33.0	58.98	0.301	0.000	58.48	0.18	3.05	55.54	58.45	0.287	3.898	298.49	30.12
LB2	*Loch Ba ring dyke*	*wr lch*	*0.002025*	*0.3*	*19.0-43.0*	*57.53*	*0.176*	*5.171*	*56.6*	*0.208*	*5.72*	*66.898*	*56.57*	*0.233*	*6.92*	*298.77*	*3.65*
MD1	Dyke	felsic gmass	0.001969	0.3	21.0-33.0	60.28	0.204	0.037	58.07	0.23	9.125	66.77	58.53	0.4	10.24	285.58	7.2
MD2	Dyke	felsic gmass	0.001952	0.3	19.0-37.0	61.38	0.188	0.045	58.33	0.266	14.89	58.11	58.3999	0.32	19.23	293.48	2.89
MD3	Dyke	plag conc	0.001932	0.3	19.0-37.0	60.598	0.203	0.026	58.04	0.197	1.681	73.46	58.09	0.334	2.12	294.2	4.84
MD1-3	Weighted Mean Age								58.12	0.13	0.42						

Table 4.3. $^{40}Ar/^{39}Ar$ dating results on samples from Mull. Samples that failed the acceptance criteria of Pringle (1992) are shown in italics. Weighted mean ages for the cross-cutting dykes, BM samples and SO samples are also included.

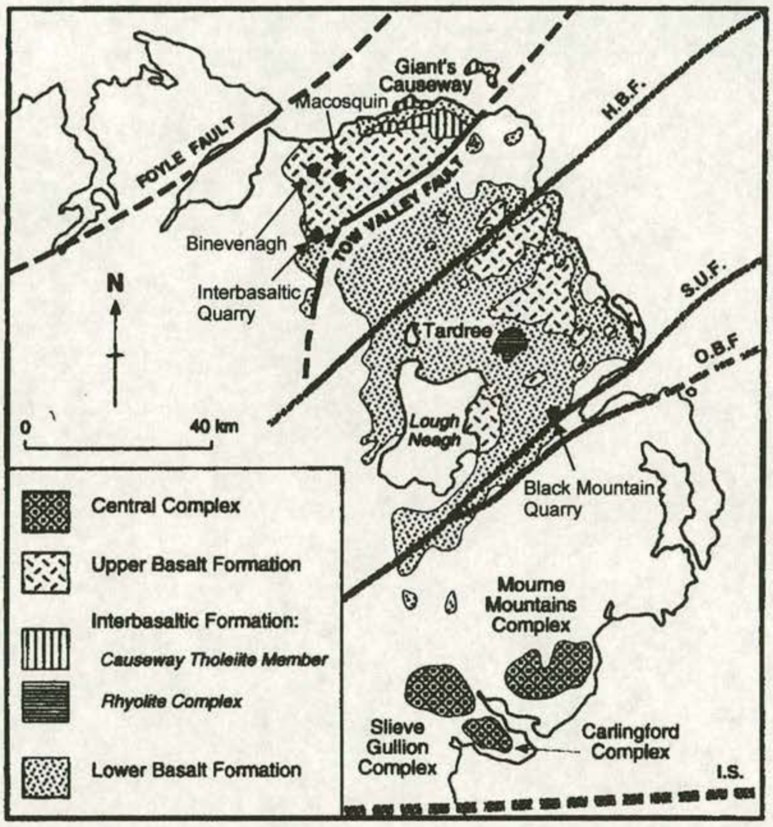


Figure 4.28. Simplified geological map of Northern Ireland. Location of the sample sites are shown as are the three central complexes of Carlingford, Slieve Gullion and Mourne.

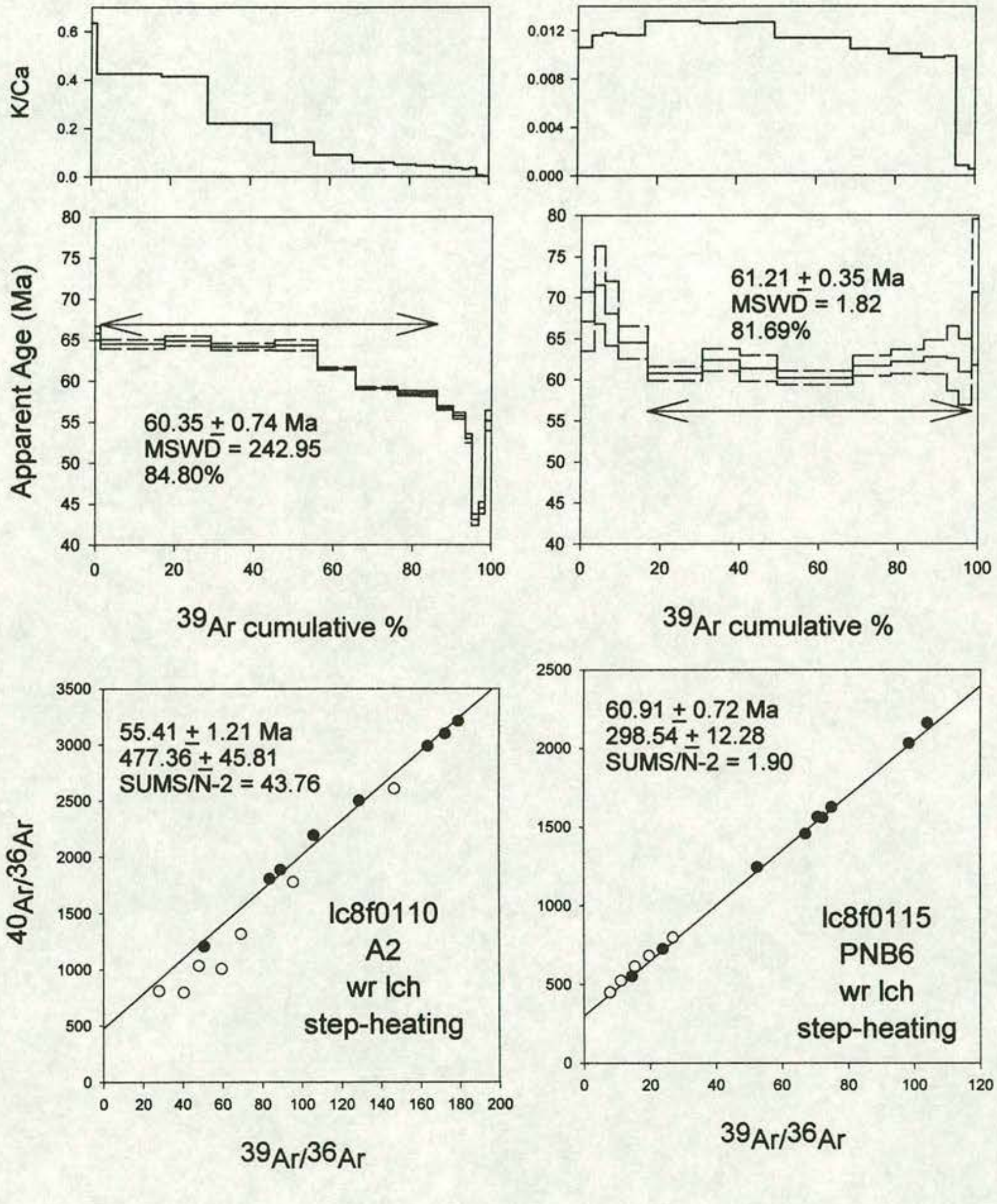


Figure 4.29. Whole rock incremental-heating experiments on samples A2 and PNB6 from the Antrim plateau basalts. Age spectra and isochron plots are shown for both samples.

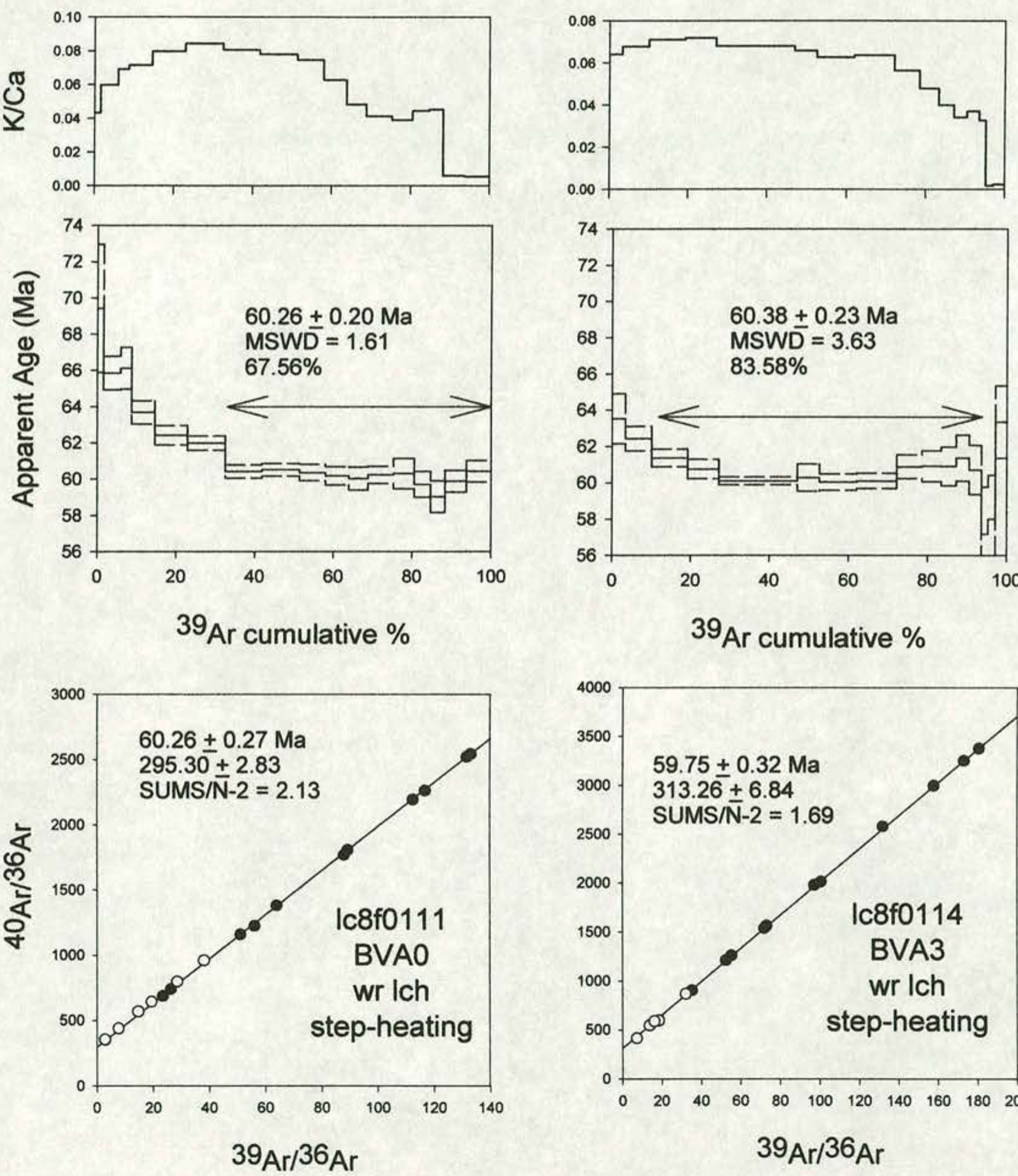


Figure 4.30. Whole rock incremental-heating experiments for samples BVA0 and BVA3 from the Antrim plateau basalt sequence.

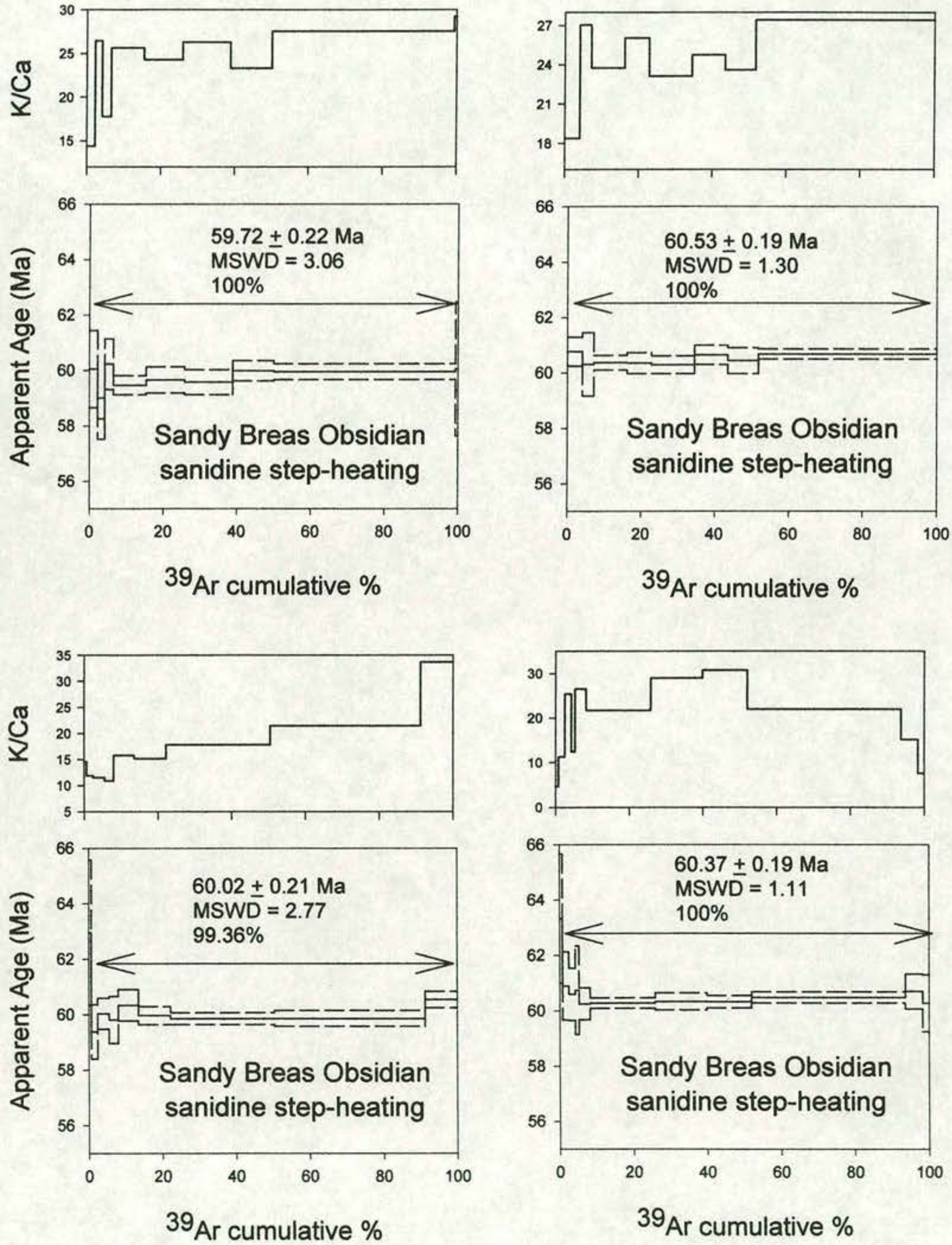


Figure 4.31. Single crystal laser incremental-heating experiments on sanidine from the Sandy Braes obsidian, Antrim. Age spectra are shown for four of the sanidines analysed.

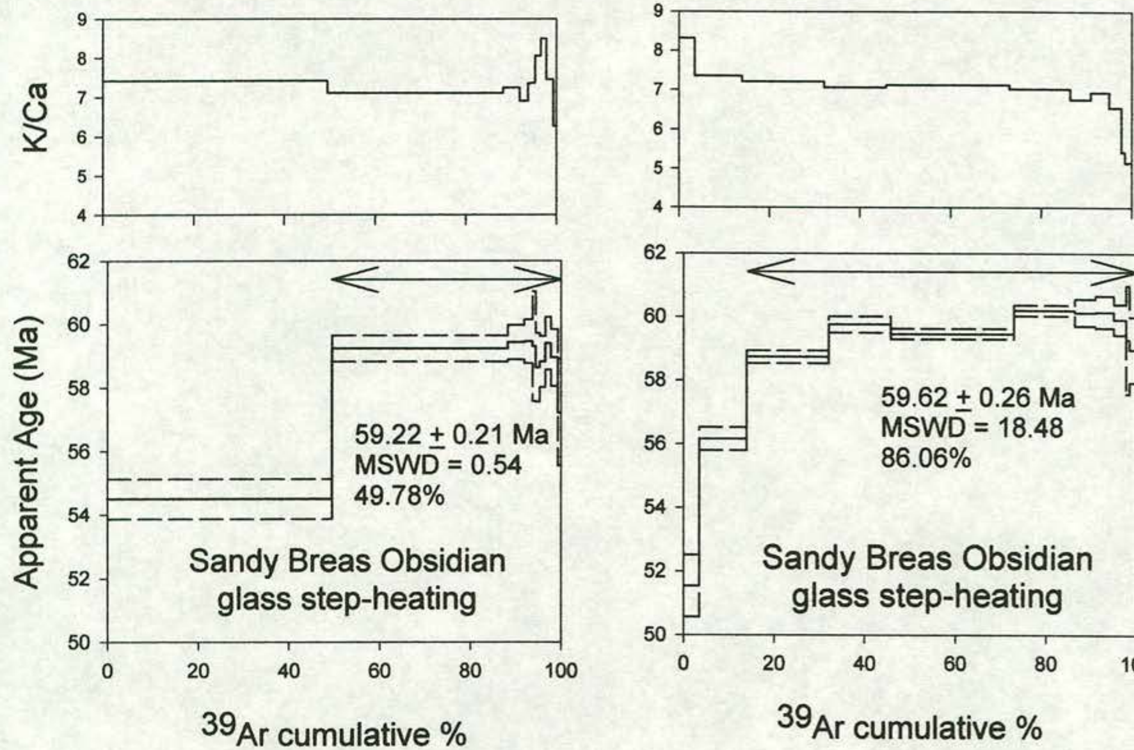


Figure 4.32. Laser incremental-heating experiments for two glass samples from the Sandy Braes obsidian. Age spectra are shown for the two samples.

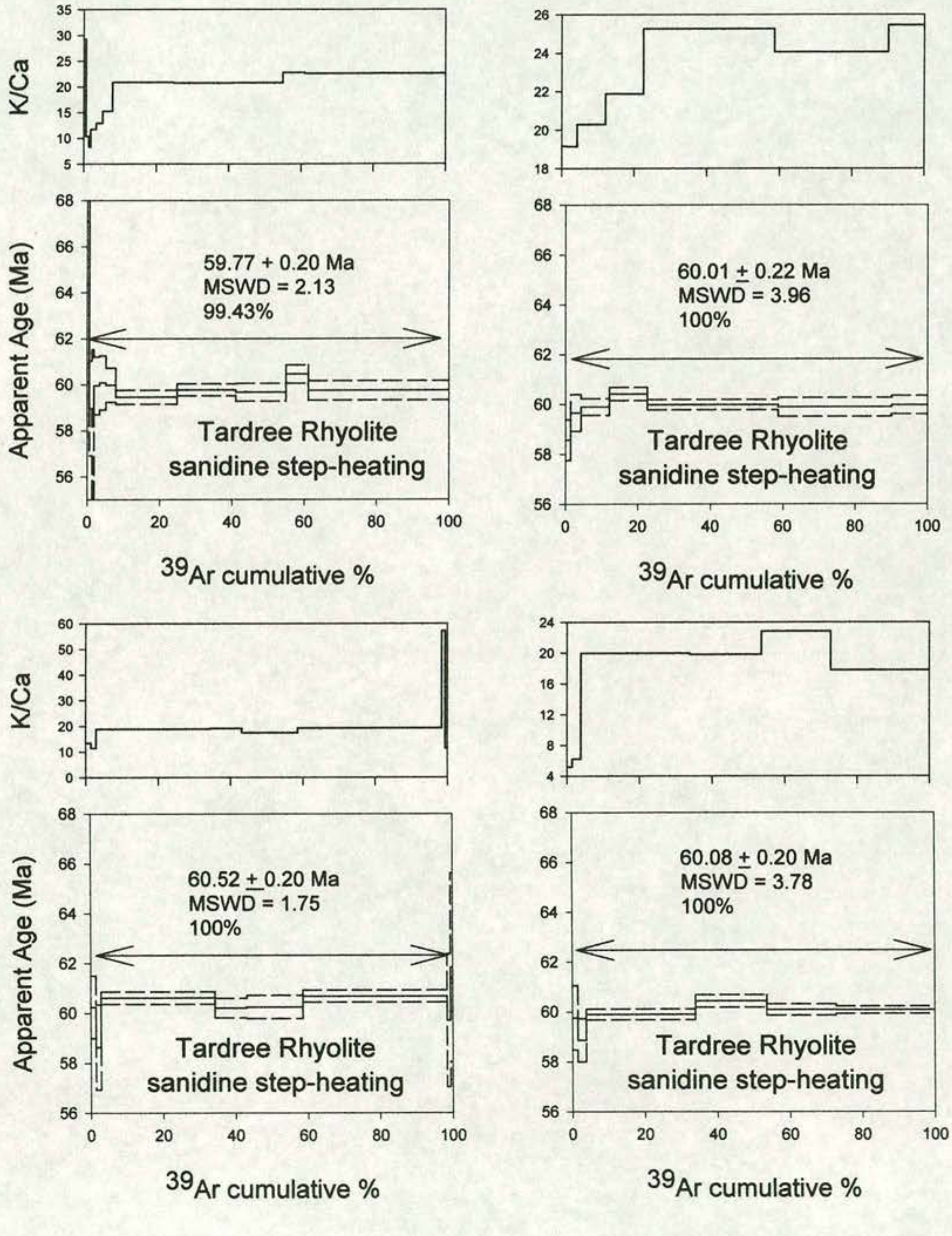


Figure 4.33. Single crystal laser incremental-heating experiments on sanidine from the Tardree rhyolite. Age spectra for four crystals are shown.

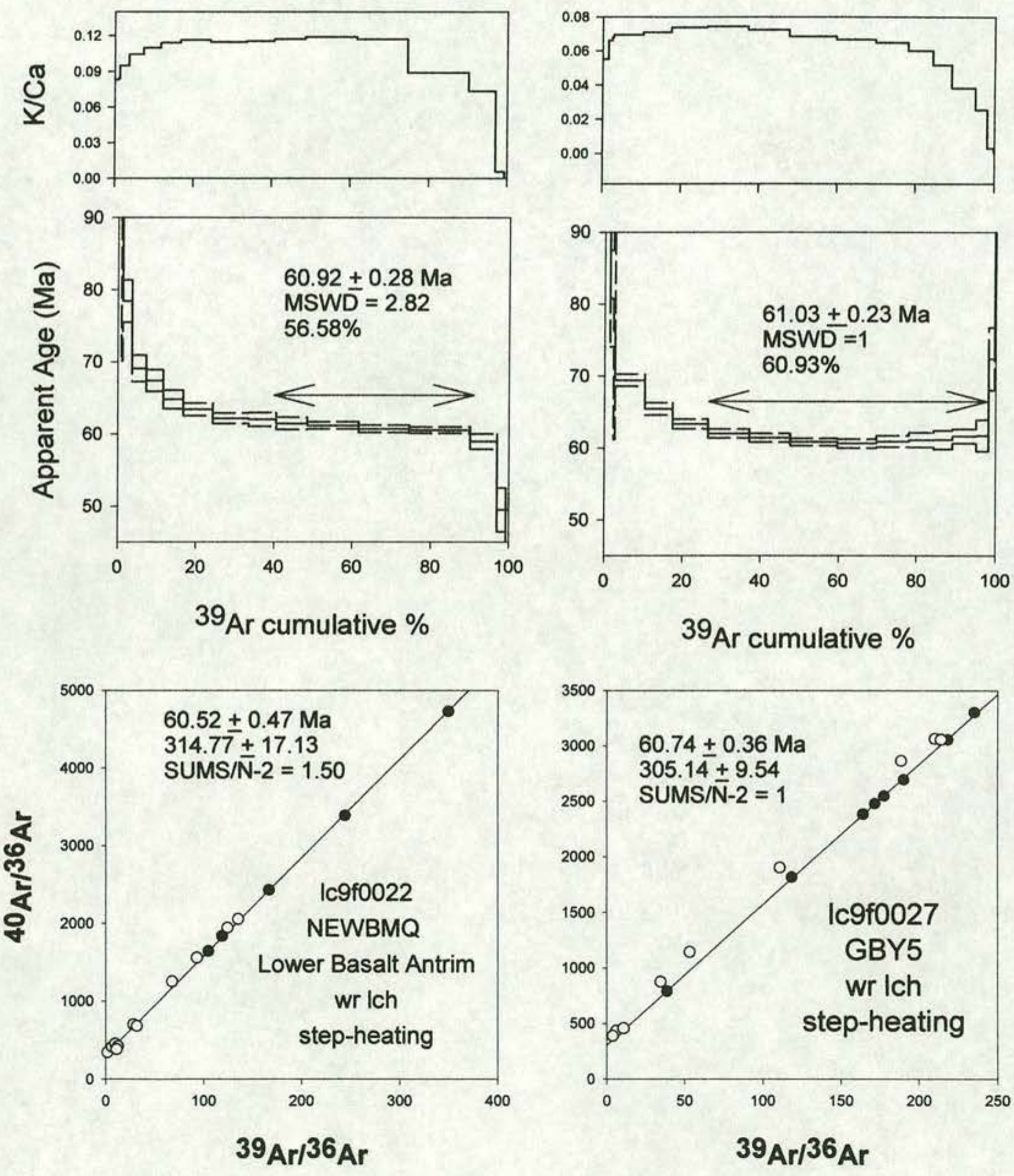


Figure 4.34. Whole rock incremental-heating experiments on two Antrim Lower basalt samples (NEWBMQ and GBY5). Age spectra and isochron plots for the two experiments are shown.

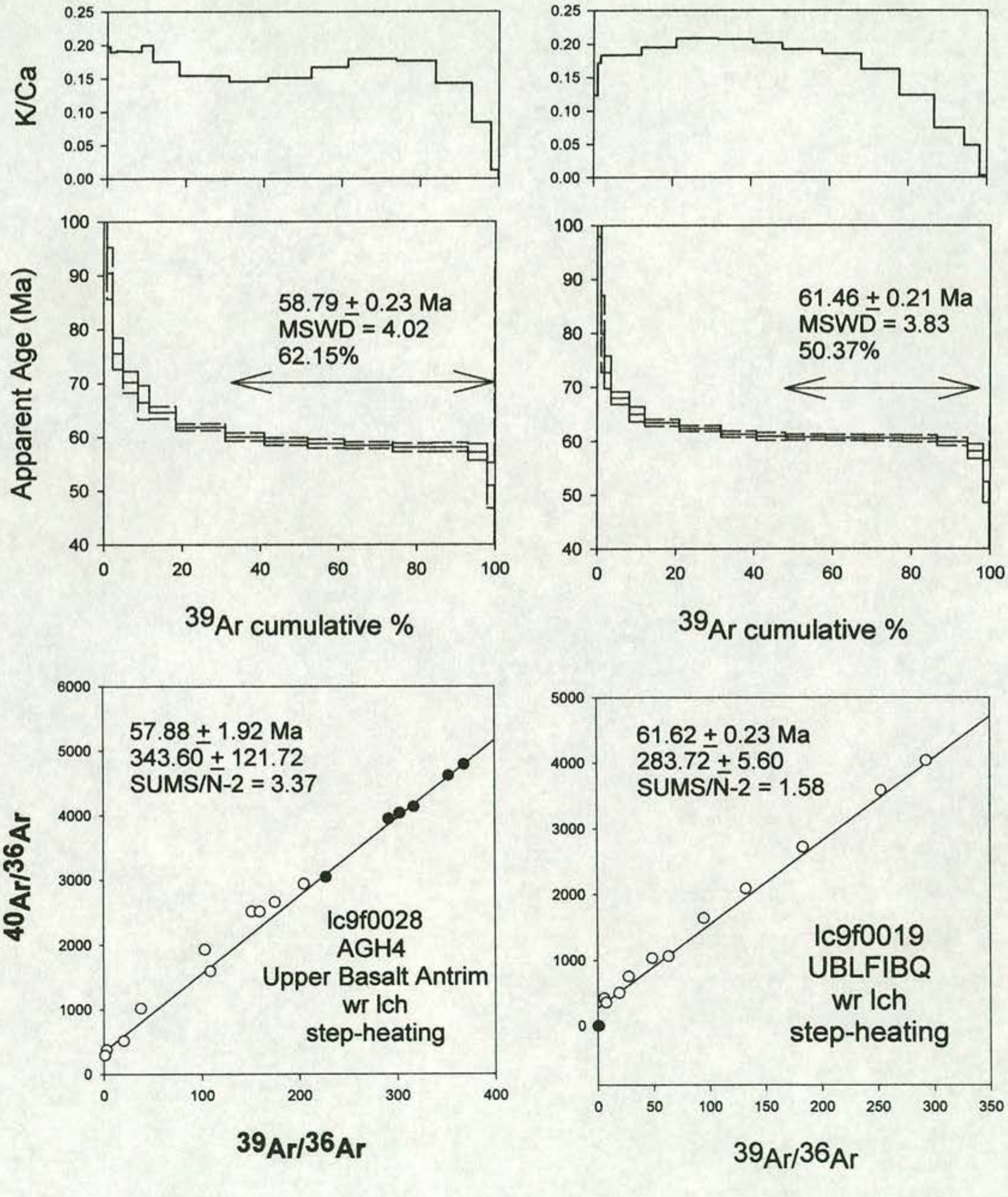


Figure 4.35. Whole rock incremental-heating experiments on two Upper basalt samples from Antrim (AGH4 and UBLFIBQ).

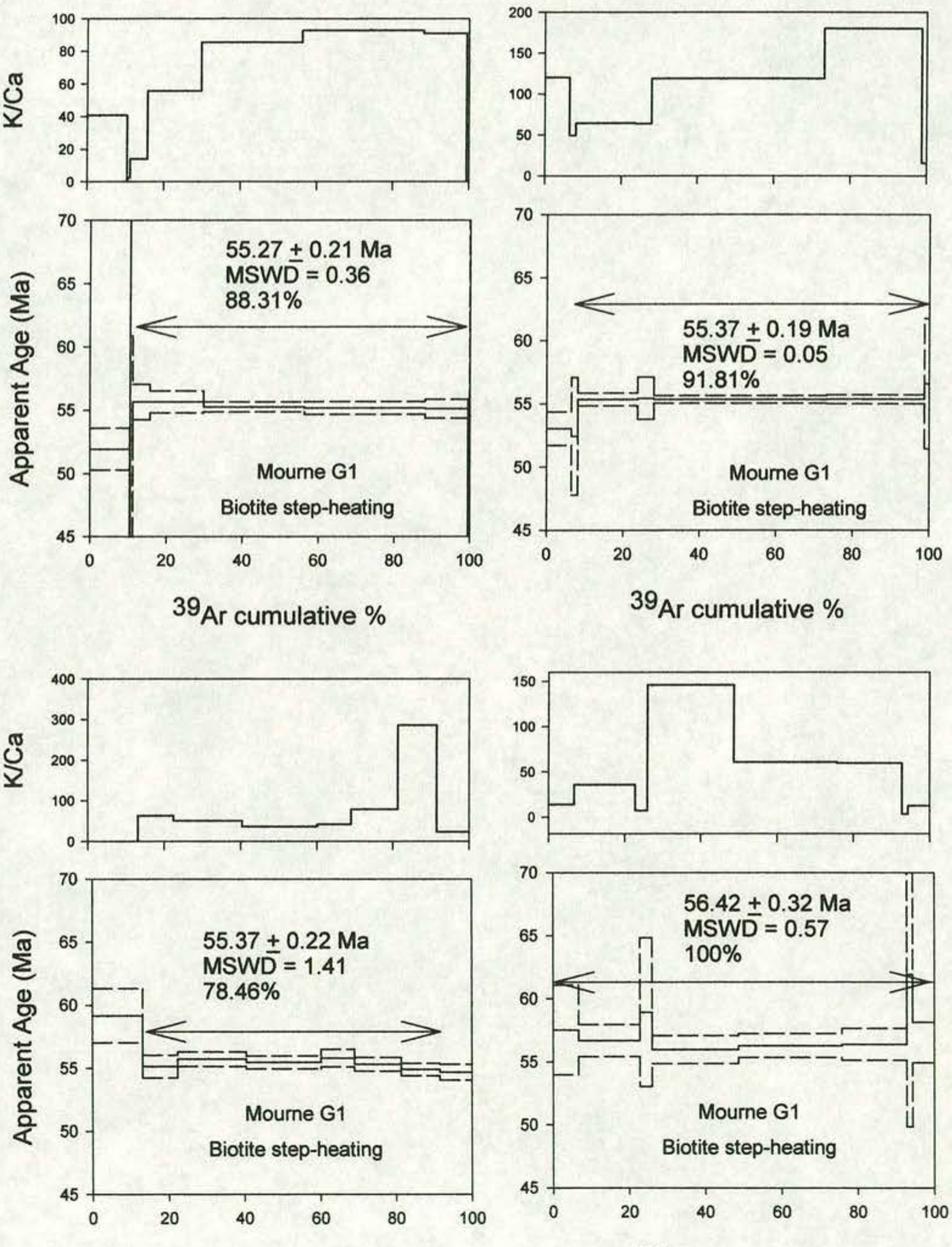


Figure 4.36. Single crystal laser incremental-heating experiments on biotite from the Mourne Mountains granite number 1. Age spectra for four experiments are shown.

Sample	Name	Material	J value	Sd J	Steps	TF age	Error	Total K/Ca	WMPA	Sd	MSWD	Cum. Ar%	Iso age	Error	Sums/n-2	Intercept	Error
A2	Causeway Member	wr Ich	0.002026	0.3	14.0-22.5	61.4	0.2	0.200000	60.35	0.74	243.0	84.796	55.41	1.21	43.76	477.36	45.81
AGH4	Upper basalt, Antrim	wr Ich	0.002704	0.3	20.2-33.0	61.4	0.25	0.16	58.8	0.35	4.0	62.15	57.88	1.92	3.37	343.6	121.72
GBY5	Lower basalt, Antrim	wr Ich	0.002709	0.3	18.3-33.0	63.57	0.23	0.064	61.03	0.23	0.9	60.93	60.75	0.36	0.8	305.14	9.54
NEWBMQ	Lower basalt, Antrim	wr Ich	0.002698	0.3	24.5-36.0	62.59	0.23	0.1	60.93	0.28	2.8	56.58	60.52	0.47	1.5	314.77	17.13
UBLFIBQ	Upper basalt, Antrim	wr Ich	0.002711	0.3	20.0-37.0	63.4	0.19	0.17	61.46	0.21	3.8	50.37	61.62	0.23	1.58	283.72	5.6
PNB6	Causeway Member	wr Ich	0.001963	0.3	19.0-37.0	62.44	0.38	0.019920	61.21	0.35	1.8	81.69	60.91	0.88	1.9	298.5	12.28
Lower (+BVA)	Weighted Mean Age								61.02	0.08	9.1						
BVA0	Upper basalt, Antrim	wr Ich	0.002009	0.3	19.0-43.0	61.32	1.96	0.058926	60.26	0.203	1.6	67.56	60.26	0.27	2.13	295.3	2.83
BVA3	Upper basalt, Antrim	wr Ich	0.001984	0.3	16.0-30.0	60.74	0.2	0.058828	60.38	0.23	3.6	63.58	59.75	0.45	1.69	313.26	6.84
BVA	Weighted Mean Age								60.31	0.15	0.2						
SBO	Sandy Braes Obsidian	sanidine	0.00094	0.3	2.5-10	59.81	0.2	25.87	59.72	0.22	3.1	100	59.69	0.2	1.13	297.58	3.15
SBO	Sandy Braes Obsidian	sanidine	0.0009374	0.3	2.1-fuse	60.05	0.19	21.35	60.05	1.87	1.4	99.13	59.86	0.3	2.8	348.21	147.95
SBO	Sandy Braes Obsidian	sanidine	0.0009522	0.3	2.6-fuse	60.56	0.19	55.57	60.53	0.19	1.3	100	60.48	0.21	1.72	308.49	48.44
SBO	Sandy Braes Obsidian	sanidine	0.00094	0.3	2.9-fuse	60.02	0.2	30.48	59.97	0.22	1.9	97.55	59.89	0.23	0.5	168	43.2
SBO	Sandy Braes Obsidian	sanidine	0.00947	0.3	1.8-fuse	59.97	0.19	19.86	60.02	0.21	2.8	99.36	59.96	0.25	2.3	302.26	91.47
SBO	Sandy Braes Obsidian	sanidine	0.0009477	0.3	1.7-10	60.43	0.19	23.22	60.37	0.19	1.1	100	60.73	0.23	6.97	229.5	53.64
SBO	Weighted Mean Age	sanidine							60.16	0.09	2.0						
SBOG	Sandy Breas Obsidian	glass	0.0009405	0.3	3.2-9	56.87	0.24	7.3	59.22	0.21	0.5	49.79	59.26	0.27	0.69	291.91	7.07
SBOG	Sandy Breas Obsidian	glass	0.0009481	0.3	2.0-fuse	58.91	0.18	7.1	59.62	0.26	18.5	86.06	59.54	0.47	24.05	286.65	95.05
SBOG	Weighted Mean Age	glass							59.62	0.26	1.4						
TR	Tardree Rhyolite	sanidine	0.0009326	0.3	2.3-10	59.77	0.2	21.08	59.77	0.2	2.1	99.43	59.63	0.24	1.11	213.38	140.82
TR	Tartdree Rhyolite	sanidine	0.0009481	0.3	3.3-fuse	59.97	0.19	23.91	60.01	0.22	4.0	100	59.77	0.26	4.85	256.95	37.89
TR	Tardree Rhyolite	sanidine	0.0009481	0.3	2.1-fuse	60.51	0.19	18.91	60.52	0.2	1.8	100	60.28	0.28	3.31	285.05	16.29
TR	Tardree Rhyolite	sanidine	0.0009378	0.3	2.2-fuse	59.92	0.19	25.21	59.88	0.19	2.0	98.21	59.83	0.22	1.97	294.75	46.42
TR	Tardree Rhyolite	sanidine	0.0009328	0.3	2.5-fuse	59.82	0.19	15.21	59.75	0.21	3.3	96.8	59.72	0.22	2.97	279.12	31.62
TR	Tardree Rhyolite	sanidine	0.0009405	0.3	2.1-fuse	60.07	0.18	19.36	60.08	0.2	3.8	100	59.86	0.28	7.43	309.75	126.91
TR	Weighted Mean Age	sanidine							60	0.08	2.0						
SBO + TR	Weighted Mean Age	sanidine							60.07	0.06	1.8						
G1	Mourne G1	biotite	0.0009354	0.3	16.-2.6	54.82	0.23	75.28	55.27	0.21	0.4	88.31	54.78	0.53	0.06	324.26	6.83
G1	Mourne G1	biotite	0.0009354	0.3	1.8-fuse	55.19	0.2	121.33	55.37	0.19	0.6	91.81	55.61	0.23	0.79	280.49	11.22
G1	Mourne G1	biotite	0.0009386	0.3	1.9-3.0	55.86	0.24	60.86	55.37	0.22	1.4	78.46	55.56	0.56	1.39	253.69	79.93
G1	Mourne G1	biotite	0.0009386	0.3	1.5-fuse	56.66	0.35	67.43	56.42	0.32	0.6	100	56.87	0.38	1.26	291.31	9.71
G1	Weighted Mean Age	biotite							55.47	0.11	3.4						

Table 4.4. $^{40}Ar/^{39}Ar$ dating results for samples from Antrim and Ireland. Experiments in italics failed the acceptance criteria of Pringle (1992). Weighted mean ages for the Sandy Braes obsidian and the Tardree rhyolite are also included.

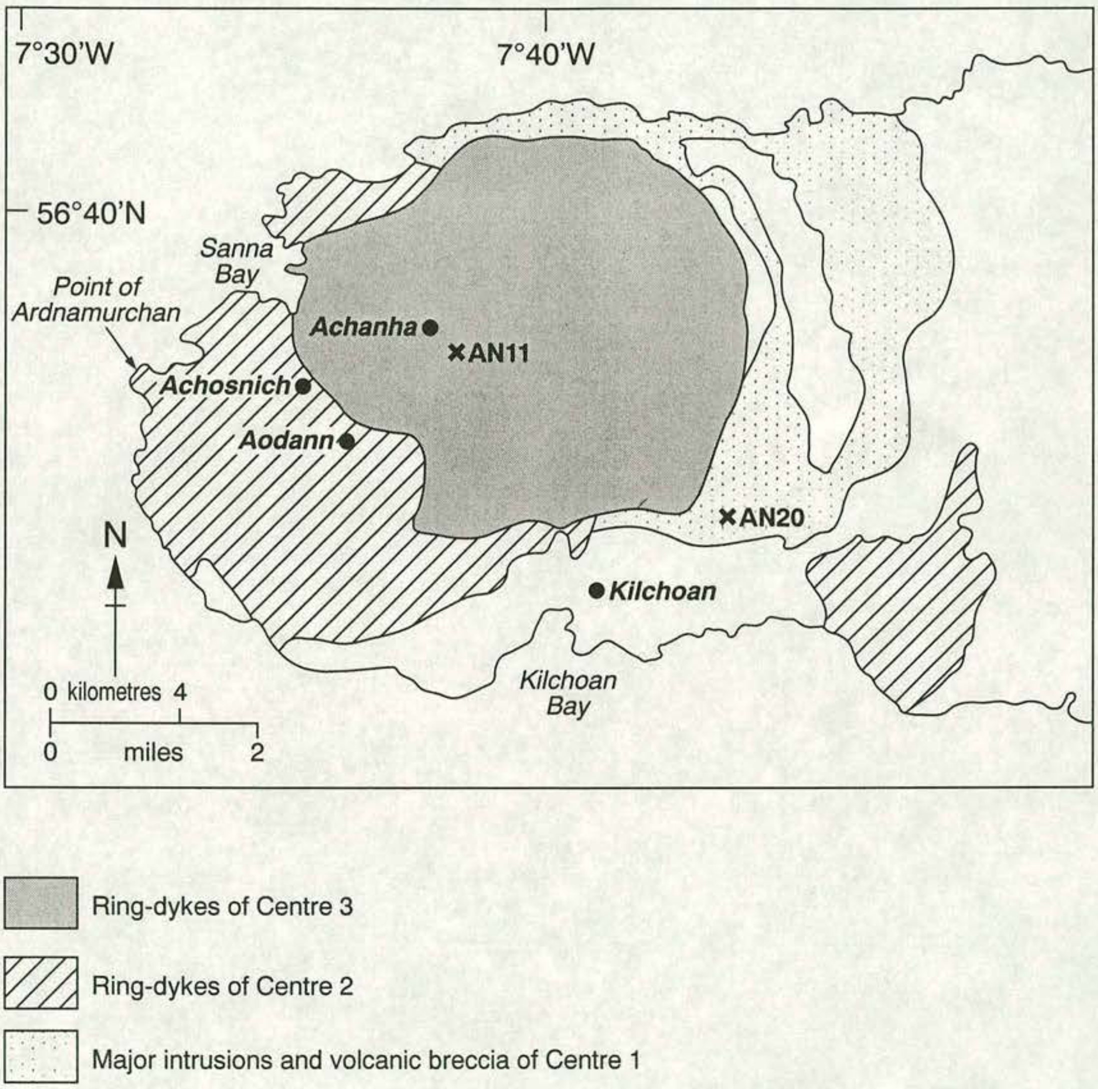


Figure 4.37. Simplified geological map of Ardnamurchan, redrawn from Emeleus and Gyopari (1992). The location of the three igneous centres and the two samples analysed by $^{40}Ar/^{39}Ar$ are shown.

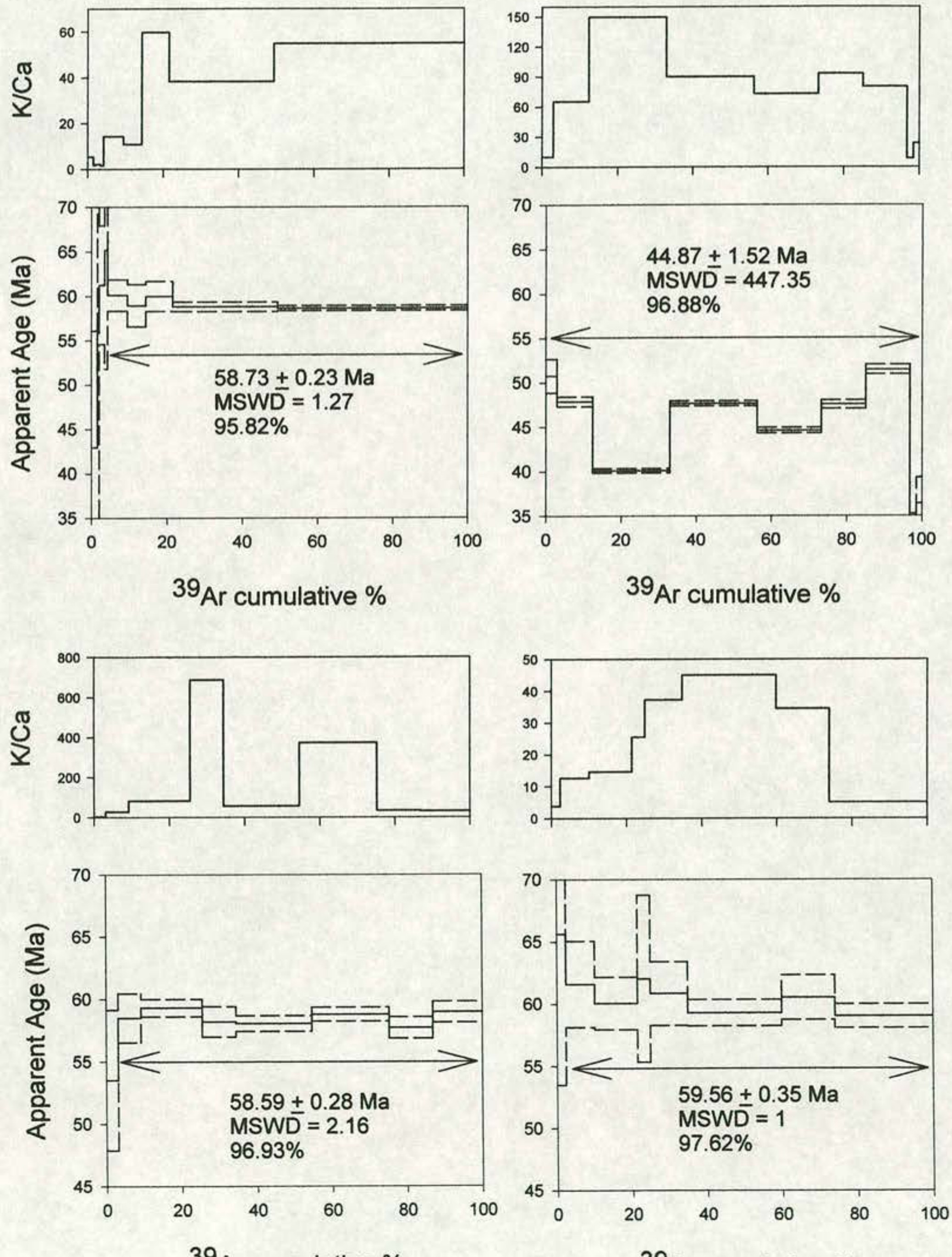
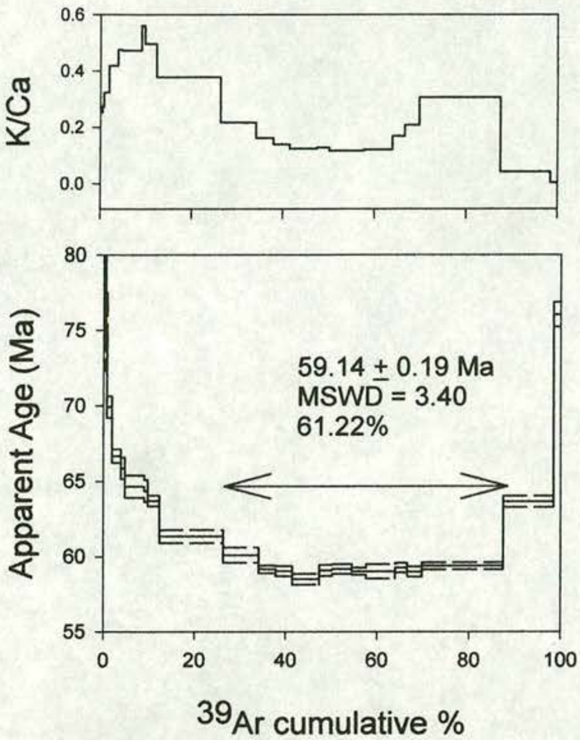


Figure 4.38. Laser incremental-heating experiments on four biotite crystals from a Centre 3 biotite gabbro, Ardnamurchan. Age spectra are shown for all four experiments.



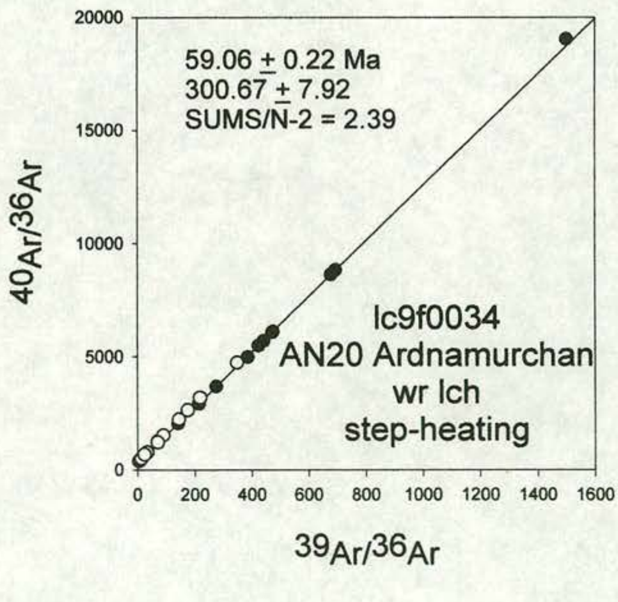


Figure 4.39. Whole rock incremental-heating experiment on sample AD20, a dolerite from Centre 1, Ardnamurchan. The age spectrum and isochron for this experiment are both shown.

Sample	Name	Material	J value	Sd J	Steps	TF age	Error	Total K/Ca	WMPA	Sd	MSWD	Cum. Ar%	Iso age	Error	Sums/n-2	Intercept	Error
AN20	Ardnamurchan	wr lch	0.002711	0.3	23.0-36.0	61.13	0.19	0.23	59.14	0.09	3.4	61.22	59.06	0.14	2.39	300.67	7.92
AN11	C3 Ardnamurchan	biotite	0.0009385	0.3	1.8-3.4	58.7	0.26	44.08	58.73	0.23	1.27	95.82	58.9	0.49	1.59	273.54	71.35
AN11	*C3 Ardnamurchan*	*biotite*	*0.0009385*	*0.3*	*2.1-3.8*	*45.73*	*0.16*	*91.67*	*44.81*	*1.34*	*351.33*	*100*	*57.89*	*0.79*	*1.93*	*339.68*	*49.29*
AN11	C3 Ardnamurchan	biotite	0.0009366	0.3	2.2-fuse	58.4	0.24	172.23	58.59	0.28	2.16	96.93	57.89	0.79	1.93	339.68	49.29
AN11	C3 Ardnamurchan	biotite	0.0009422	0.3	2.9-fuse	60.05	0.4	24.7	59.56	0.35	0.96	97.62	60.41	0.86	8.31	140.28	123.38
AN11	Weighted Mean Age	biotite							58.82	0.16	1.8						

Table 4.5. $^{40}Ar/^{39}Ar$ dating results for the Ardnamurchan samples. A weighted mean age for the C3 gabbro is included. Experiments that failed the acceptance criteria of Pringle (1992) are shown in italics.

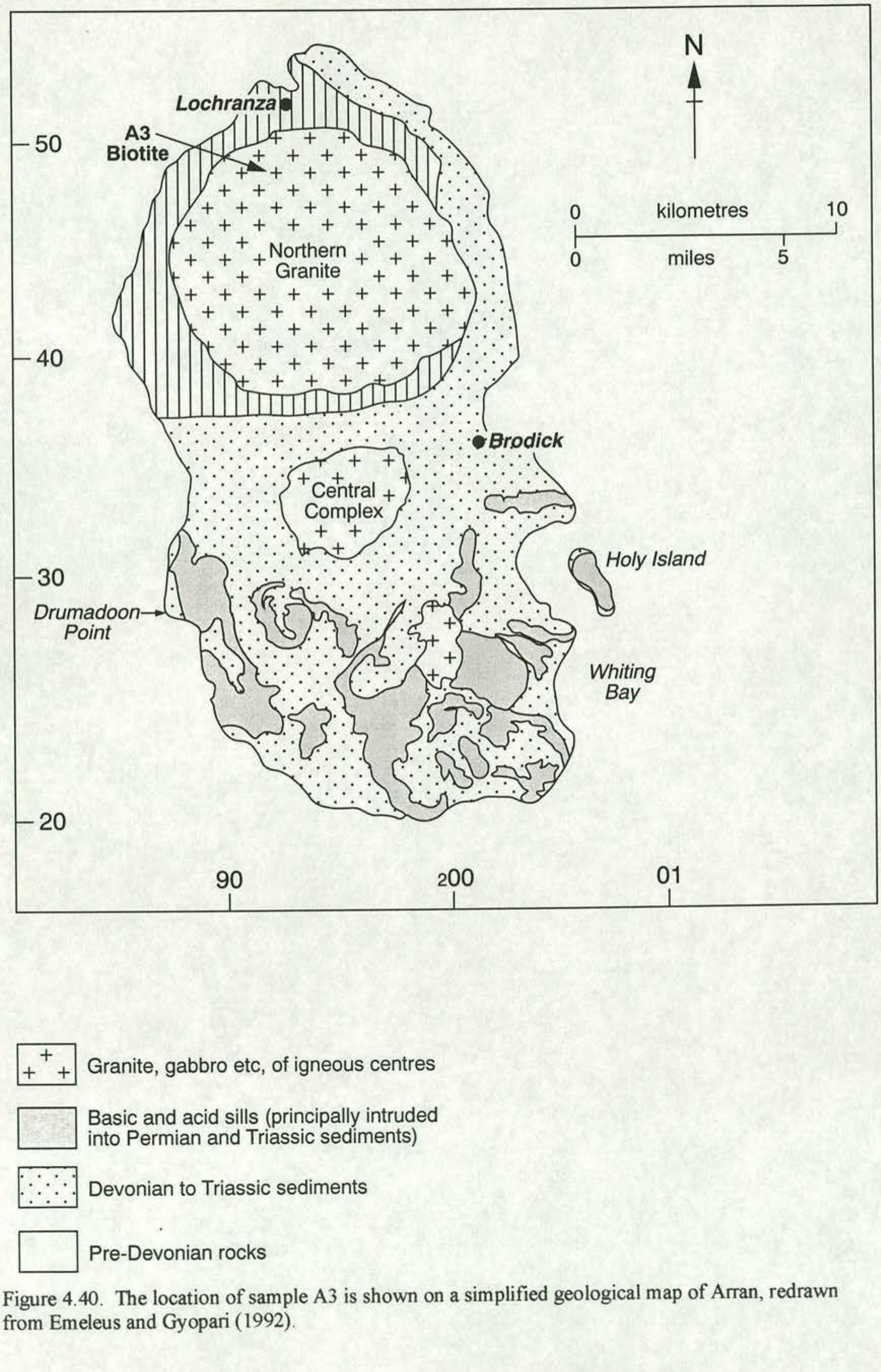


Figure 4.40. The location of sample A3 is shown on a simplified geological map of Arran, redrawn from Emeleus and Gyopari (1992).

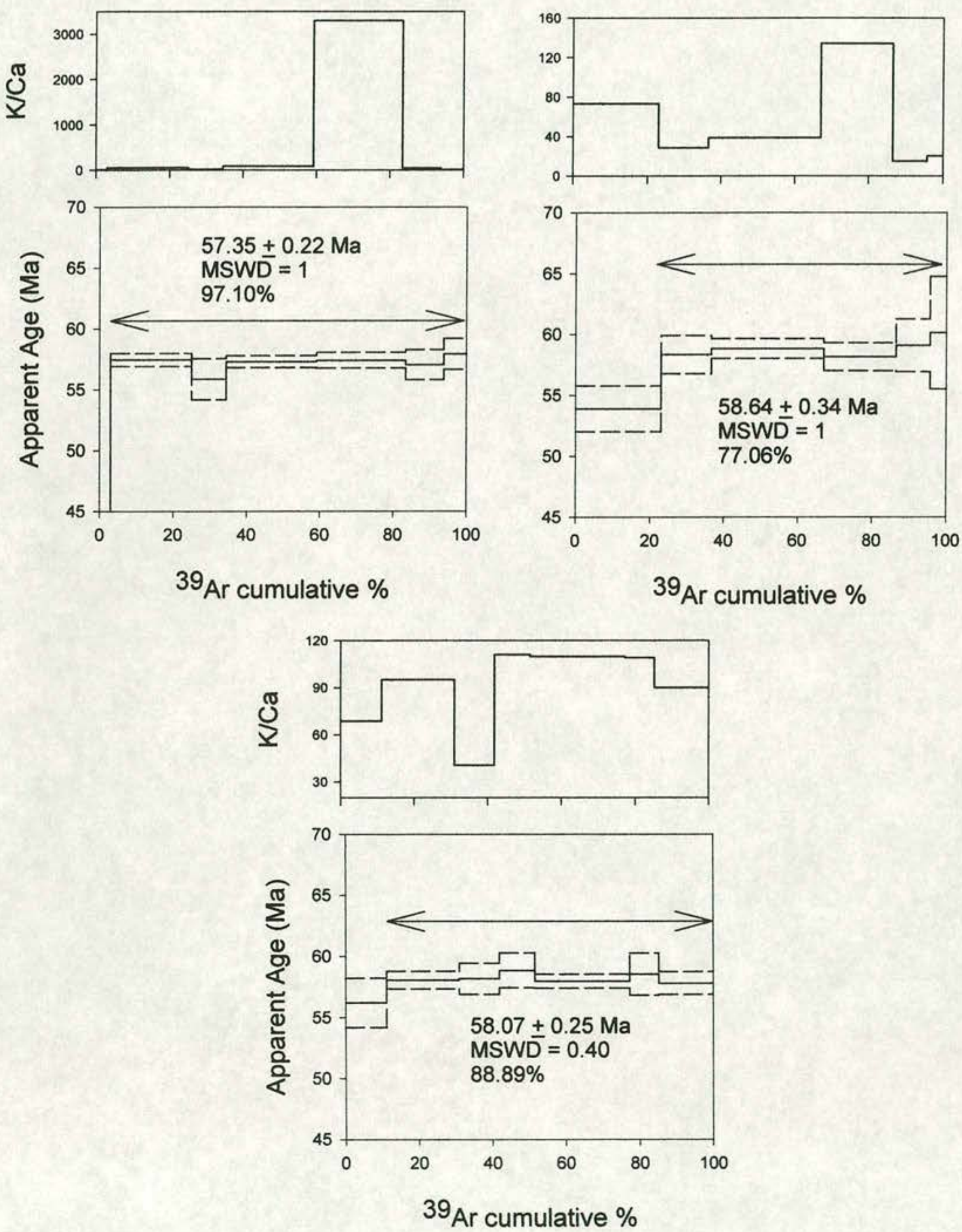


Figure 4.41. Examples of single crystal incremental-heating experiments on biotites for the North Arran granite. Only age spectra are shown.

Sample	Name	Material	J value	Sd J	Steps	TF age	Error	Total K/Ca	WMPA	Sd	MSWD	Cum. Ar%	Iso age	Error	Sums/n-2	Intercept	Error
A3	Outer Granite, Arran	biotite	0.000942	0.3	`1.5-fuse	56.64	0.25	838.92	57.35	0.22	0.88	97.1	57.43	0.28	0.78	280.32	12.17
A3	Outer Granite, Arran	biotite	0.000942	0.3	1.7-3.0	59.6	0.36	60.92	58.64	0.34	0.42	77.06	58.54	0.91	0.5	301.53	29.89
A3	Outer Granite, Arran	biotite	0.000938	0.3	1.8-fuse	57.92	0.27	91.9	58.07	0.25	0.4	88.89	58.12	0.37	0.52	299.19	18.94
A3	Weighted Mean Age	biotite							57.85	0.15	5.67						

Table 4.6. Ar-Ar dating results for the North Arran granite including the weighted mean age. Italics denote those experiments that failed the acceptance criteria of Pringle (1992).

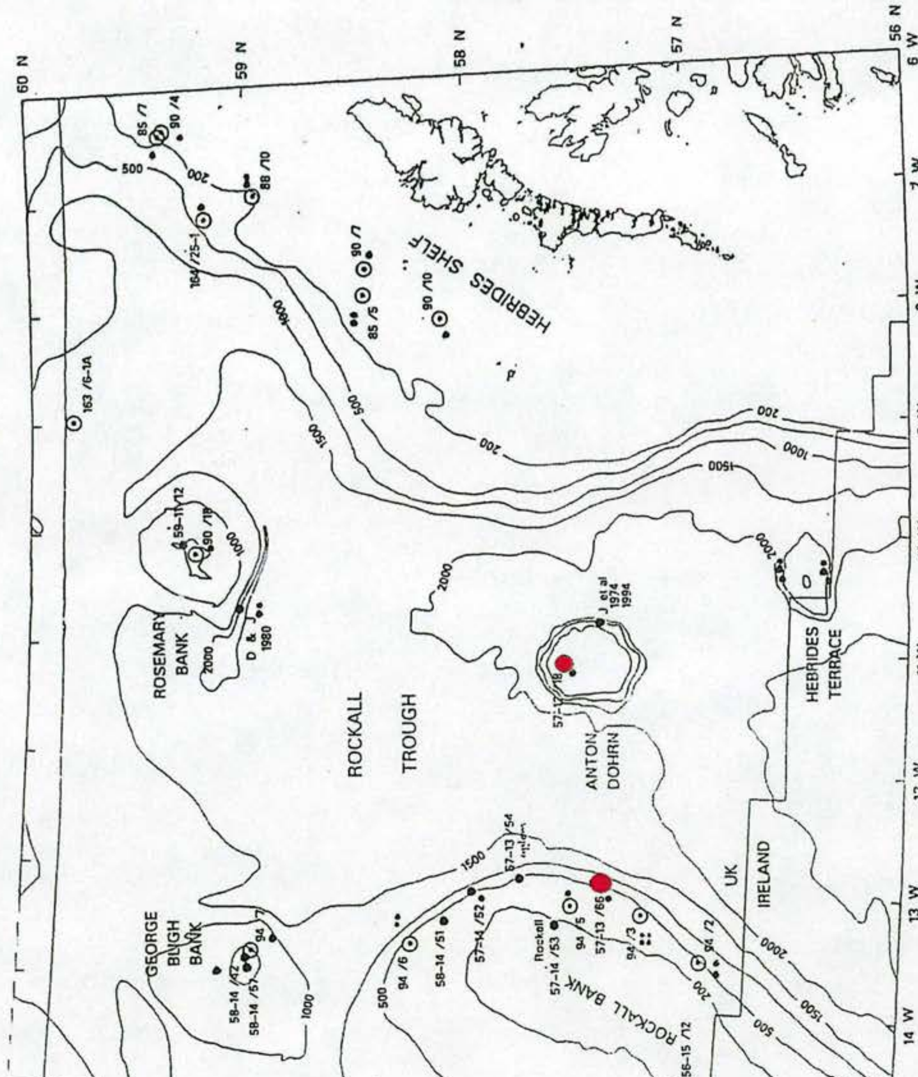


Figure 4.42. Location of the samples analysed from West of Shetland.

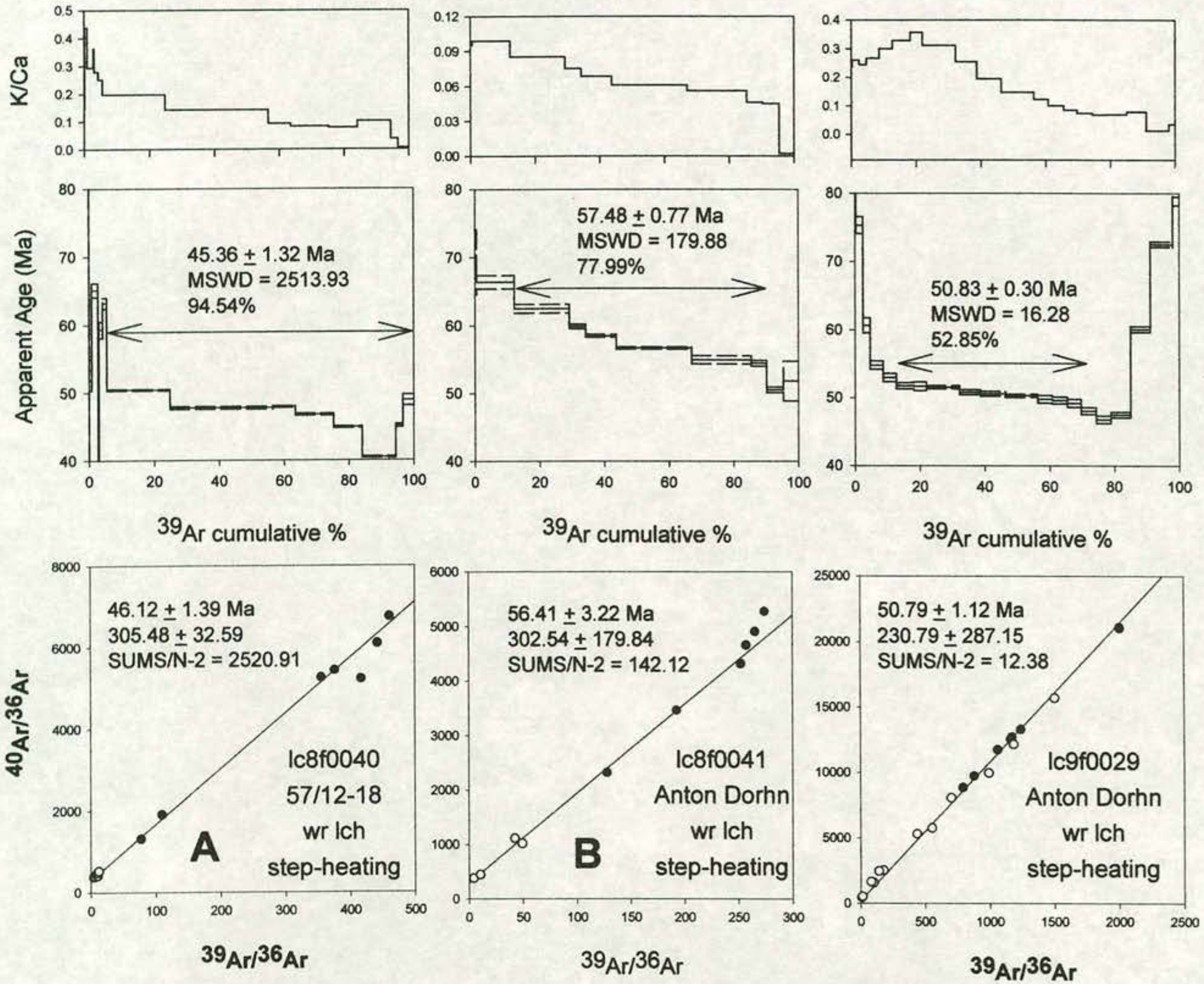


Figure 4.43. Whole rock incremental-heating experiments for a sample from Rockall (A) and a sample from Anton Dorhn (B). Age spectra and isochrons are shown for both samples. The second Anton Dorhn sample (C) was leached in HNO_3 and HCl.

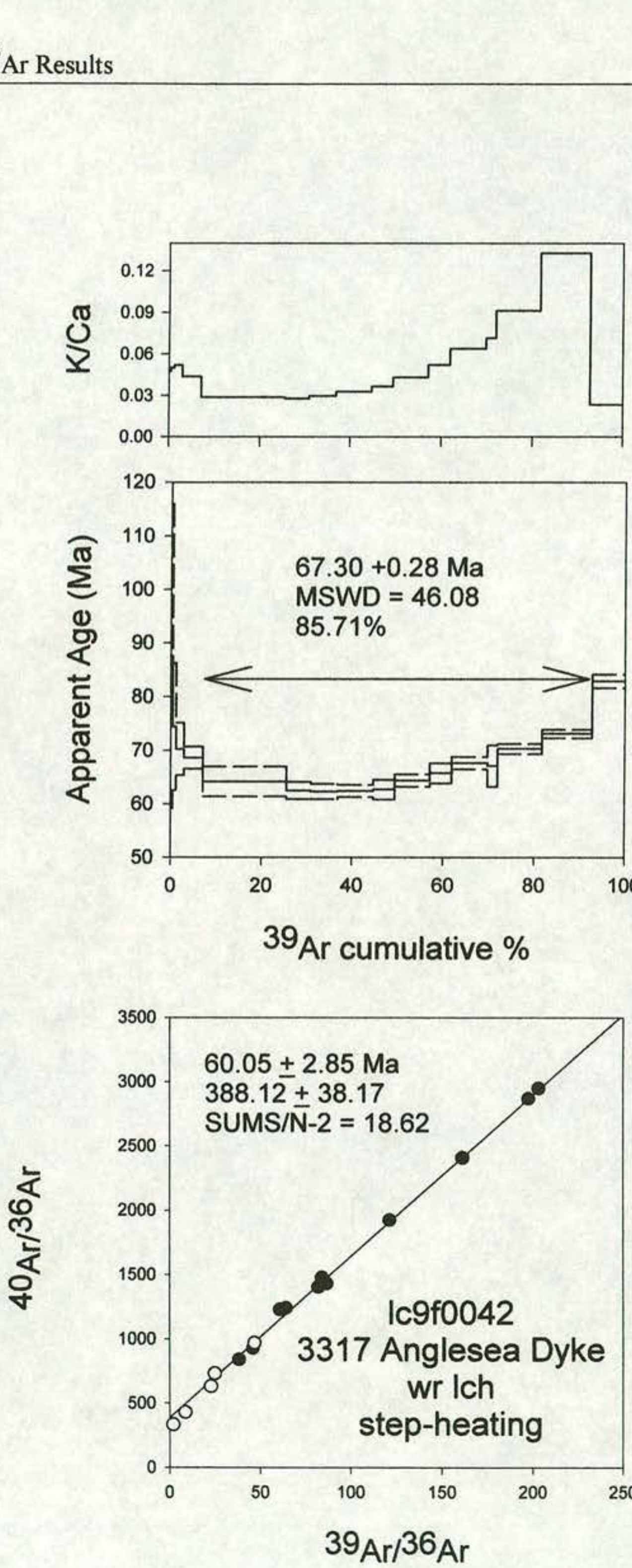


Figure 4.44. Whole rock incremental-heating experiment on a dyke from the Anglesey swarm (3317). The age spectrum and isochron are shown. The non-atmospheric intercept indicates the presence of excess argon in this sample.

Sample	Name	Material	J value	Sd J	Steps	TF age	Error	Total K/Ca	WMPA	Sd	MSWD	Cum. Ar%	Iso age	Error	Sums/n-2	Intercept	Error
57-12/18	Anton Dorhn	wr lch	0.0019	0.3	22.5-43.0	47.44	0.147	0.14	45.36	1.33	2513.9	94.54	46.12	1.39	2520.909	305.47	32.59
57-12/18	Anton Dorhn	wr lch	0.002694	0.3	17.0-24.2	54.01	0.17	0.18	50.83	0.3	16.28	52.85	50.79	1.12	21.38	230.79	287.15
57-13/66	Rockall	wr lch	0.0019	0.3	18.0-43.0	57.03	0.208	0.07	55.93	0.858	244.13	100	50	1.69	37.17	418.29	331.7
3317	Anglesey	wr lch	0.002698	0.3	18.0-40.0	68.39	0.23	0.05	66.8	1.31	274.75	85.71	61.73	2.15	126.61	374.69	32.91

Table 4.7. $^{40}Ar/^{39}Ar$ dating results for samples from Rockall and Anton Dorhn. Results shown in italics indicate that they failed the acceptance criteria of Pringle (1992).

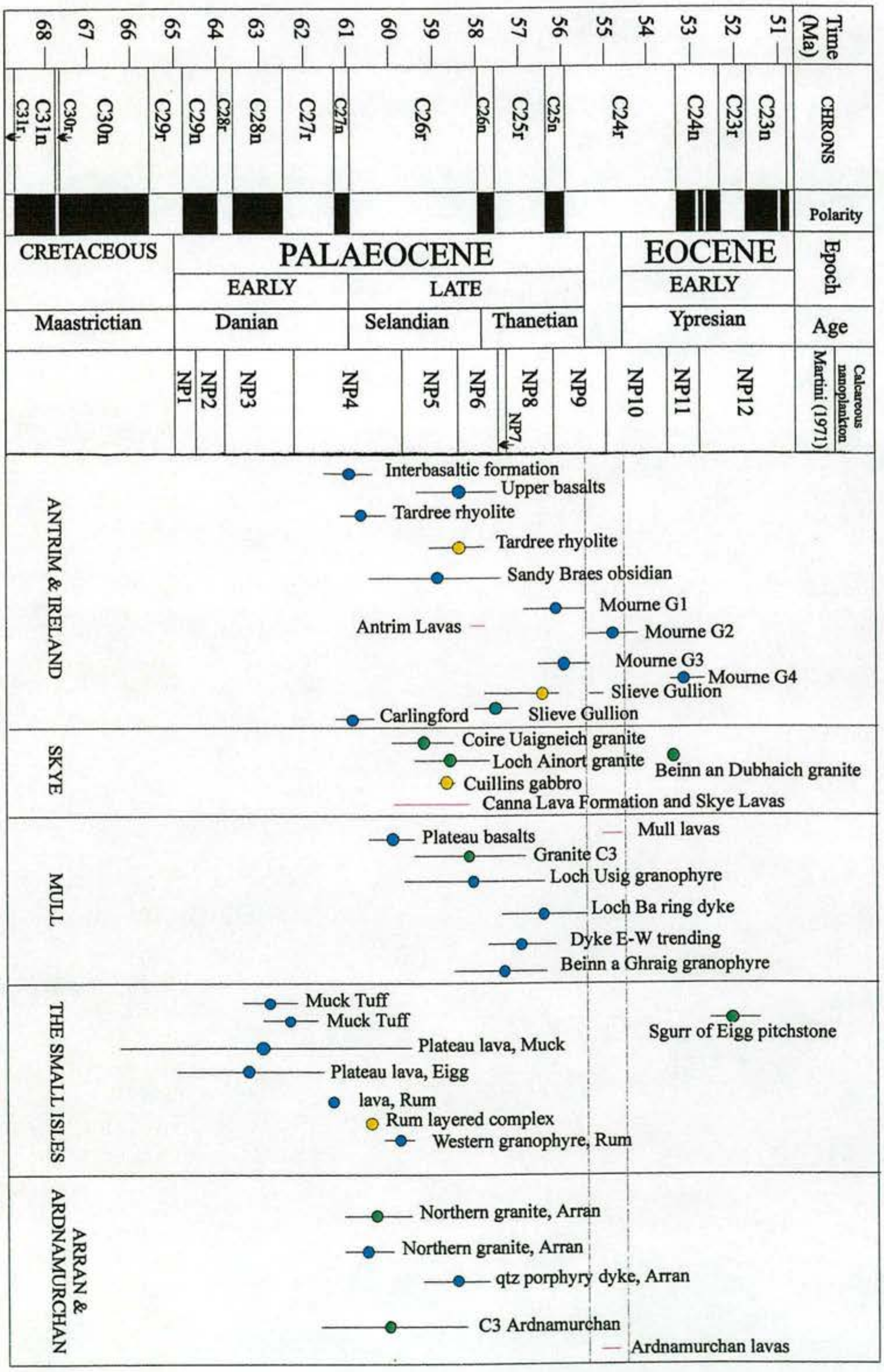


Figure 4.45. Published ages for the BTIP prior to this study (Table 2.2, Chapter 2) plotted on the timescale of Berggren *et al.* (1995). The large errors associated with some of these ages are apparent. Relative stratigraphy cannot be resolved. Light blue = Ar-Ar; green = Rb/Sr; yellow = U/Pb. Palynological ages from Bell and Jolley (1997) and Jolley (1997) are shown as red lines

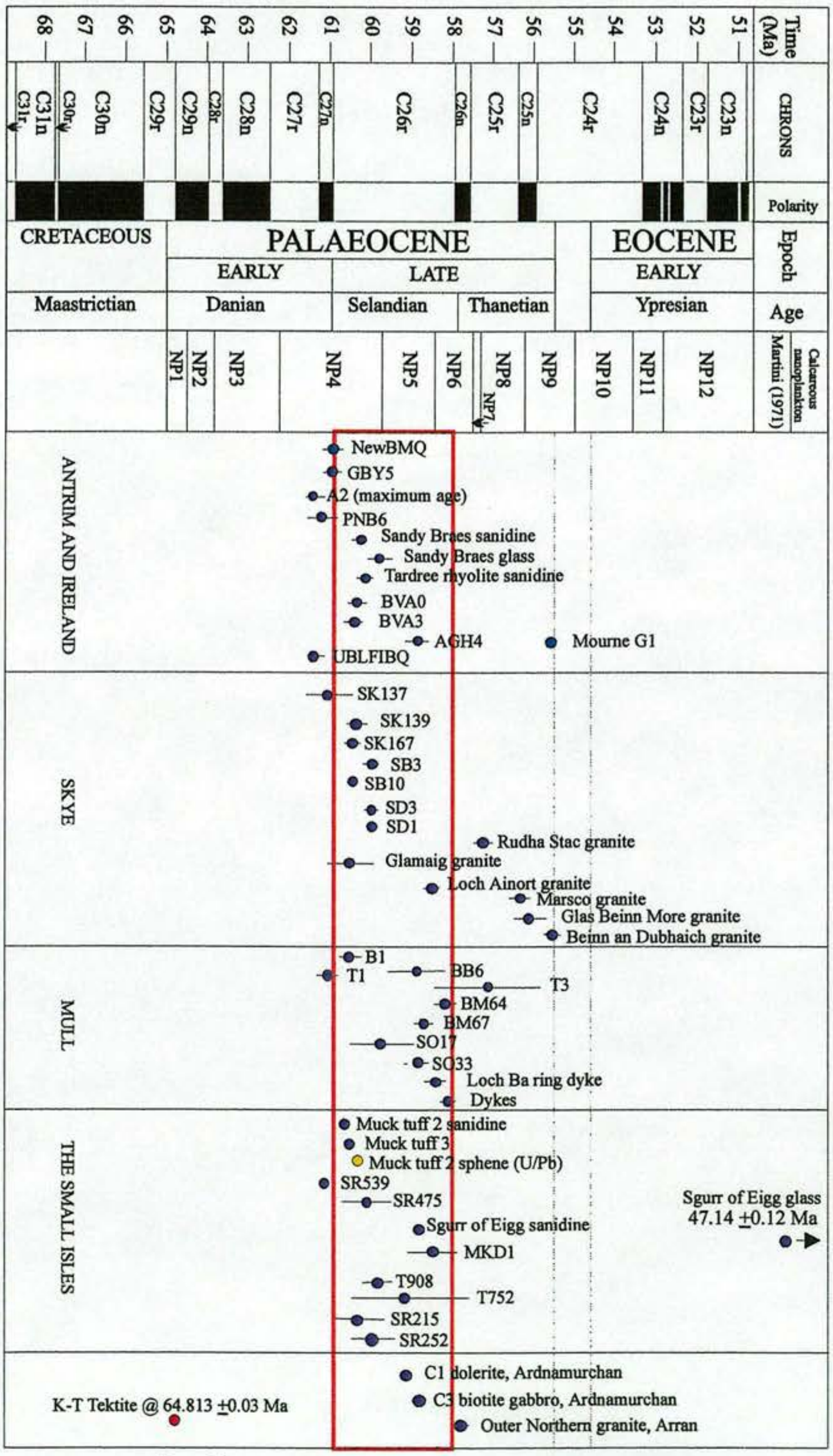


Figure 4.46. The new $^{40}Ar/^{39}Ar$ ages (blue) from this study that meet the acceptance criteria and the one U/Pb age (yellow) are plotted on the geomagnetic timescale of Berggren *et al.* (1995). Volcanic activity in the BTIP is confined to a 3 m.y. duration (red box). The K-T tektite is also shown as it is the direct reference point to the timescale (red).

Location	Sample No.	Sample	Age	Error	MSWD	Age type	Notes
Mull	B1	basal lava	60.56	0.29	14.88	plateau	
	BB6	basal lava	58.88	0.7	3.36	isochron	excess Ar
	T1	basal lava	61.36	0.2	53.99	TFA	discordant
	T3	basal lava	57.10	3.32	1	isochron	excess Ar
	BM64 & 67	700m	58.38	0.19	1.45	WMA	TFA ~59.5
	SO17 & 33	C1 lava	59.05	0.27	1.13	WMA	
	LB1	Loch Ba sanidine	58.48	0.18	3.05	plateau	
	MD1-3	dykes	58.12	0.13	0.42	WMA	
Skye	lavas	middle lavas	59.83	0.12	2.9	WMA	
	dykes	dykes cutting lavas	59.20	0.16	0.3	WMA	
	RGS	Rudha Stac granite	57.27	0.3	1.34	WMA	
	GG	Glamaig granite	60.54	0.65	2.61	plateau	
	LAG	Loch Ainort granite	58.58	0.13	2.04	WMA	
	MG	Marsco granite	56.40	0.29	2.47	WMA	
	GBMG	Glas Bheinn Mhor granite	55.26	0.42	4.82	WMA	
	BDG	Beinn an Dubhaich granite	55.44	0.22	7.03	WMA	
Antrim	Lower		61.02	0.08	9.06	WMA	
	Middle		60.07	0.06	1.77	WMA	
	AGH4	(Upper)	58.79	0.35	4.02	plateau	
	G1	Mourne	55.47	0.11	3.4	WMA	
Muck	MT2	basal tuff	60.65	0.07	0.75	WMA	
	MT2	basal tuff	60.19	0.2		U/Pb	
	MT3	basal tuff	60.44	0.07	0.12	WMA	
	T752	lava	59.12	2.41	1	isochron	excess Ar
	MKD1	dyke	58.58	1.59	11.52	isochron	excess Ar
Eigg	T908	lava	59.78	0.25	1.9	plateau	
	EP	Sgurr of Eigg	58.73	0.08	1.95	WMA	
	EPG	Sgurr of Eigg	47.14	0.12	87.05	WMA	
Rum	SR539	w. granophyre	61.13	0.32	4.1	WMA	
	SR475	w. granophyre	60.01	0.45	2.39	plateau	
	SR215	lava	60.28	0.82	5.12	isochron	saddle shape
Canna	SR252	lava	59.98	0.24	1.33	plateau	
	SR215 & 252		60.00	0.23	2.9	WMA	
Ardnamurchan	AN20	C1	59.14	0.19	3.4	plateau	
	AN11	C3	58.82	0.16	1.8	WMA	
Arran	A3	northern granite	57.85	0.15	5.67	WMA	
Rockall	57/13-66		57.03	0.21		TFA	discordant
Anton Dorhn	57/12-18		47.40	0.15		TFA	discordant
	57/12-18		54.03	0.17		TFA	discordant
Anglesey	3317		60.05	2.85	18.62	isochron	excess Ar
Beloc	KT	K-T tektite	64.81	0.03		WMA	

Table 4.8. The new $^{40}Ar/^{39}Ar$ ages from this study for the BTIP. The age for the K-T tektite is also included in the table as an absolute reference point to the geomagnetic timescale. WMA = weighted mean age; TFA = total fusion age.

The stratigraphic succession taken from Emeleus and Gyopari (1992) of the Small Isles follows:	Polarity	Radiometric age (Ma)	Age Reference
youngest			
Valley infilling pitchstone of the Sgurr of Eigg	R	58.72 ±0.07	This thesis
Dolerite dykes	N		
Lavas and fluviatile sediments of North-west Rum and Canna and Sanday, olivine basalts, hawaiites, mugerite (Canna), including also tholeiitic basaltic andesites and Icelandites on Rum. Canna Lava Formation	R	60.00 ±0.23	This thesis
Period of profound erosion during which time the Rum central complex was unroofed and eroded			
The Rum layered igneous complex			
Central series: feldspathic peridotites, inc. some layered allivalites and peridotites	R		
Western Layered Series (WLS): feldspathic peridotites and gabbroic rocks at Harris bay	R	60.53 +0.04	Hamilton *et al*, 1998
Eastern Layered Series (ELS): layered feldspathic peridotite and allivalite, gabbroic and ultrabasic intrusives	R		
(the WLS and ELS may be coeval)			
Dolerite and basalt dykes (some also post-date the layered series)	R		
Dolerite and basalt cone-sheets on Rum	R		
Early phase of acid igneous activity	R		
Western Granite, also granite at Papadil and long Loch	R	60.01 ±0.45	This thesis
Porphyritic felsite (ignimbrites in caldera and intrusions)	R		
Tuffisites (some may post-date the porphyritic felsites)	R		
Volcaniclastic breccias- probably a mixture of explosion breccias and breccias formed by caldera wall collapse.	R		
Dolerite and basalt dykes (some intruded after breccias and before felsites)	R		
Eigg Lava Formation seen in SW Rum, Eigg and Muck. Sanidine bearing tuff horizons towards the base	R	60.65 ±0.07 & 60.44 ±0.07	This thesis
oldest			

Table 5.1. A summary of the magmatic history of the Small Isles is combined with the $^{40}Ar/^{39}Ar$ ages from this thesis and Hamilton *et al.* (1998). The magnetic polarity data is from Dagley and Mussett (1981, 1986). Apart from the late dolerite dykes, all of the igneous rocks sampled have reversed magnetic polarity. A normal polarity event is inferred during the period of erosion (Dagley and Mussett, 1981).

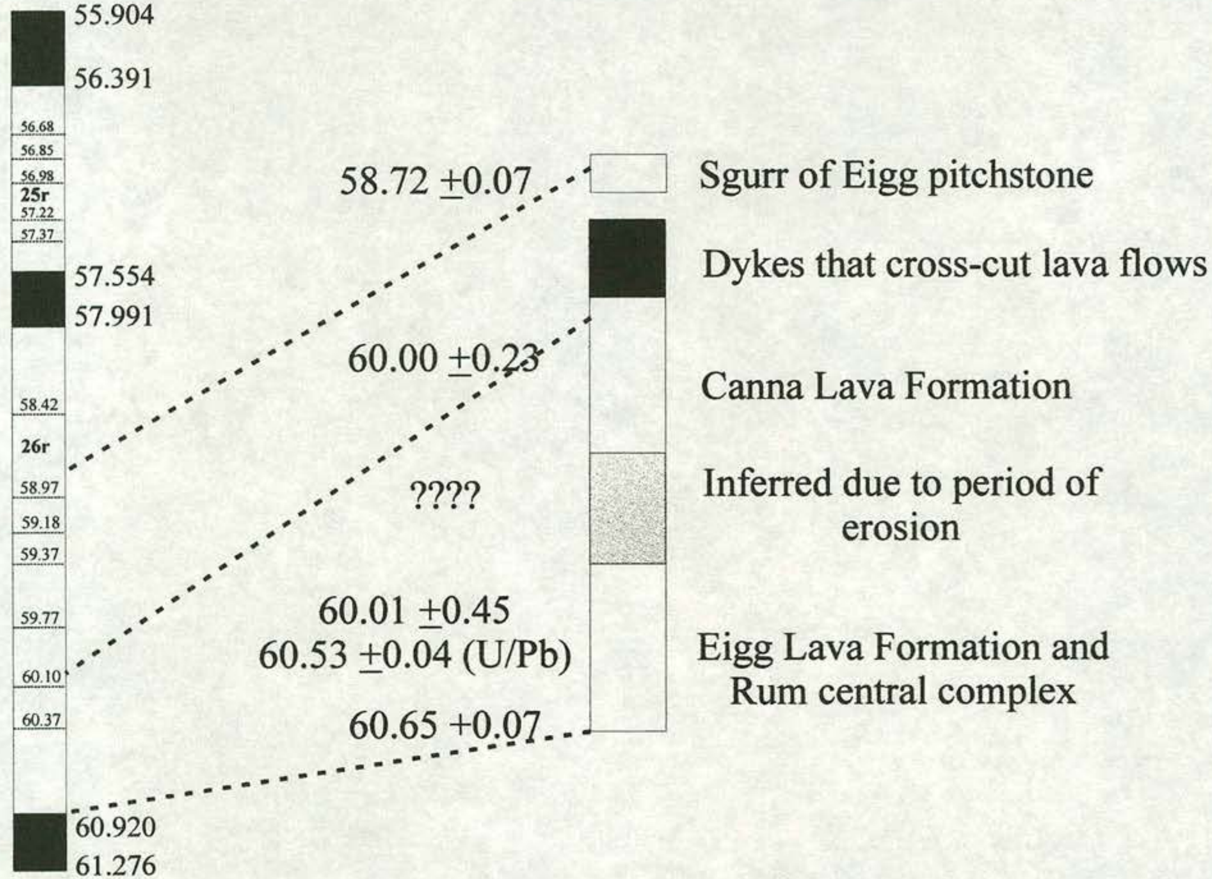


Figure 5.1. The magnetic polarity data for the Small Isles (Dagley and Mussett., 1981, 1986), the $^{40}Ar/^{39}Ar$ dates (Ma) from this thesis and the U/Pb ages from Hamilton *et al.* (1998) are shown on the geomagnetic timescale of Berggren *et al.* (1995). The normal dykes, cut by the later Sgurr of Eigg pitchstone, occur during 26r. Normal polarity events are shown in black. The possible additional normal polarity event is shown in grey.

The stratigraphic succession taken from Emeleus and Gyopari (1992) of Skye	Polarity	Radiometric age (Ma)
Late dykes (dolerite and felsite)	R	
Eastern Redhills Centre		
Composite acid/basic sheets	R	
Five granite intrusions (Glas Bheinn Mhor, inner and outer granites, Beinn an Dubhaich granite)	R	GBM @ 55.26 ±0.42, BAD @ 55.44 ±0.22
Kilchrist hybrids (probably post-date some of the granites)		
Broadford and Beinn na Cro gabbros	R	
Acid lavas, ignimbrites, tuffs and agglomerates of Kilchrist vent (may predate the centre by a considerable amount)		
Dykes (dolerite and pitchstone)	N	
Western Red Hills Centre		
Marsco and Meall Buidhe granites	N	56.40 ±0.29
Marscoite suite of hybrids etc	N	
Nine granites and major felsite intrusions from oldest to youngest (Glamaig, Maol na Gainmhich, Eas Mor, Beinn Dearg Mhor, Loch Ainort, Glen Sligachan, Southern Porphyritic, Northern Porphyritic felsite, Meall Buidhe)	N-R-N	Glamaig @ 60.54 ±0.65, Loch Ainort G @ 59.58 ±0.13
Marsco summit gabbro		
Belig vent		
Dolerite dykes		
Strath na Creitheach Centre		
Three granite intrusions (Meall Dearg, Ruadh Stac and Blaven Granites)	R	57.29 ±0.30
Loch na Creitheach vent		
Dolerite dykes	N	
Cuillin centre		
Cone sheets dolerite	R	
Coire Uaigneich granophyre	N	
Intrusive tholeiites		

Table 5.2. A summary table combining the magmatic history of Skye (Emeleus and Gyopari, 1992), the magnetic polarity (Dagley *et al.*, 1990), the $^{40}Ar/^{39}Ar$ dates from this thesis and the U/Pb ages from Hamilton *et al.* (1998). A total of nine magnetic reversals are recorded in the Tertiary rocks of Skye.

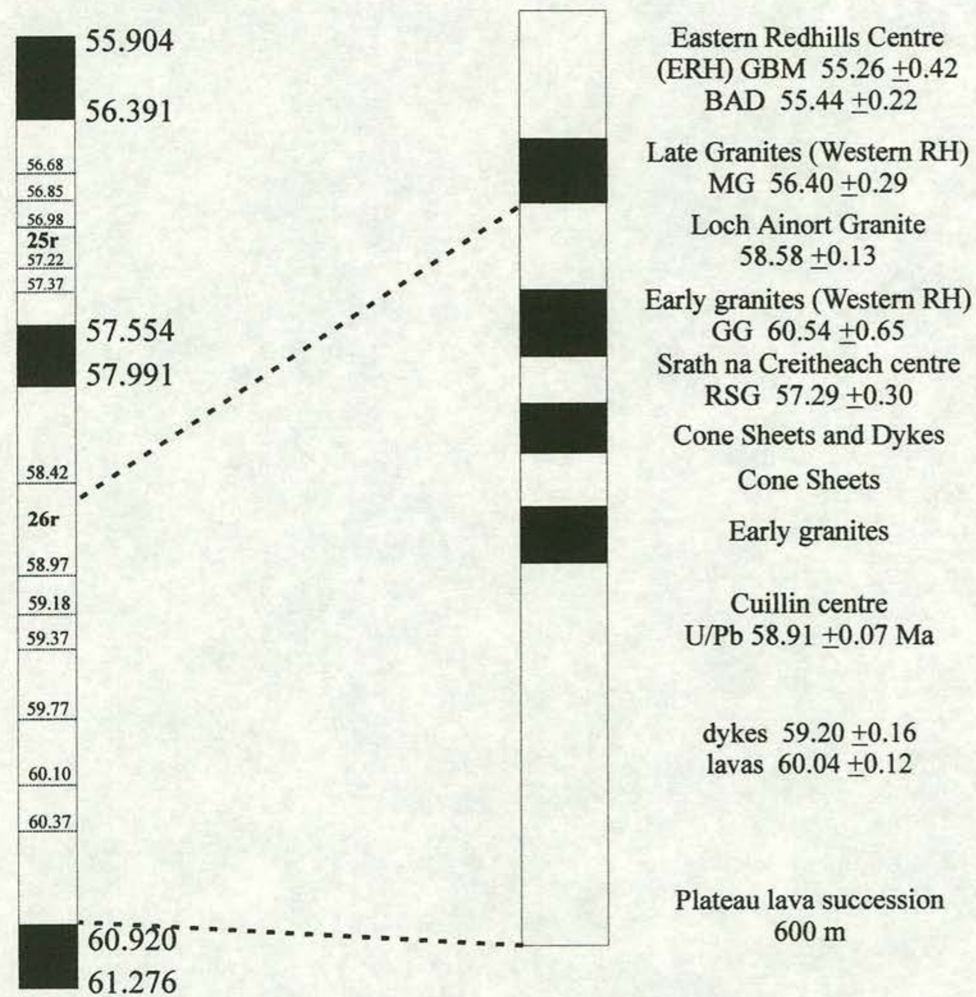


Figure 5.2. Data from the summary table for Skye (Table 5.2) is correlated to the geomagnetic timescale of Berggren *et al.* (1995). Using the radiometric ages as tie points to the timescale, most of the succession occurs within Chron 26r. This implies that three normal polarity events occur within this reversed Chron. Normal polarity Chrons are shown in black. Ages in Ma.

The stratigraphic succession taken from Emeleus and Gyopari (1992) of Mull	Polarity	Radiometric age (Ma)	Age Reference
Dykes were intruded throughout the sequence	dykes cutting Loch Ba ring dyke R	58.12 ±0.13	This thesis
Loch Ba Centre (Centre 3; north-west or late caldera)			
Loch Ba felsite ring-dyke (Allt Molach-Beinn Chaisgidle, Loch Ba-Ben More)	N	58.48 ±0.18	This thesis
Hybrid masses of Sron nam Boc and Coille na Sroine (Loch Ba-Ben More)			
Beinn na Ghraig granophyre	N		
Knock granophyre			
Late basic cone sheets	N		
Early Beinn a Ghraig granophyre and felsite			
Glen Cannel complex and some late basic cone-sheets	N		
Beinn Chaisgidle (Centre 2)			
Glen More ring dyke	N		
Late basic cone-sheets	N		
Ring dyke intrusions around Beinn Chaisgidle			
? Augite diorite masses of An Cruachan and Gaodhail	N		
Corra-Bheinn layered gabbro	N		
Second suite of early basic cone-sheets	R & N		
Second suite of early acid cone-sheets	N		
Explosion vents			
Glen More (Centre 1)			
Ben Buie layered gabbro	predominantly R		
Loch Uisg granophyre-gabbro	R		
First suite of early basic cone sheets	R & N		
Early acid and intermediate cone sheets	R		
Acid explosion vents containing porphyrtic rhyolitic material			
Glas Bheinn and Derrynaculen granophyres	R & N		
Updoming and folding in south-east Mull as a result of rising diapir			
Lava eruption onto eroded surface of Mesozoic and older rocks. Latest flows overlap with the formation of the Southeast caldera where pillow lavas are found.	R except in SE caldera where N. Outside caldera R	base 60.56 ±0.29, middle 58.38 ±0.19, inside SE caldera 59.05 ±0.27	This thesis

Table 5.3. The igneous succession in Mull summarised in Emeleus and Gyopari (1992) is combined with magnetic polarity taken from Dagley *et al.* (1987) and the radiometric ages from this thesis. There are seven changes in magnetic polarity seen in the sampled rocks of Mull. Most of the lavas have reversed polarity, while most of Centres 2 and 3 have normal polarity.

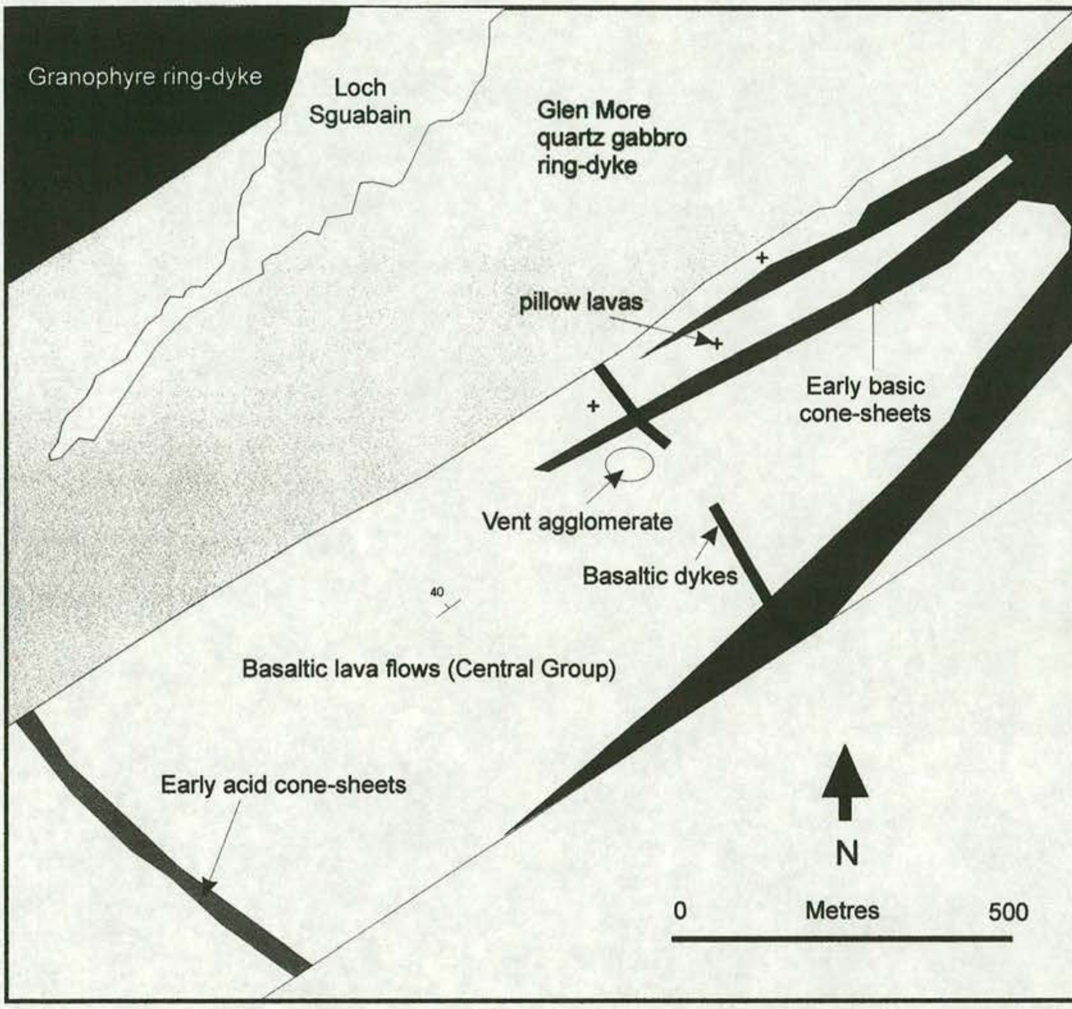


Figure 5.3. A simplified schematic diagram showing stratigraphic relationships in the Mull central complex, taken from Emeleus and Gyopari (1992). The lavas are cut by early acid cone sheets (reversed polarity) and then by the early basic cone sheets (reversed and normal polarity). All of these rocks are then cross-cut by the later normal polarity Glen More quartz gabbro. If overprinting of the lavas had been caused by the quartz gabbro then cone-sheets with reversed polarity would also have been affected.

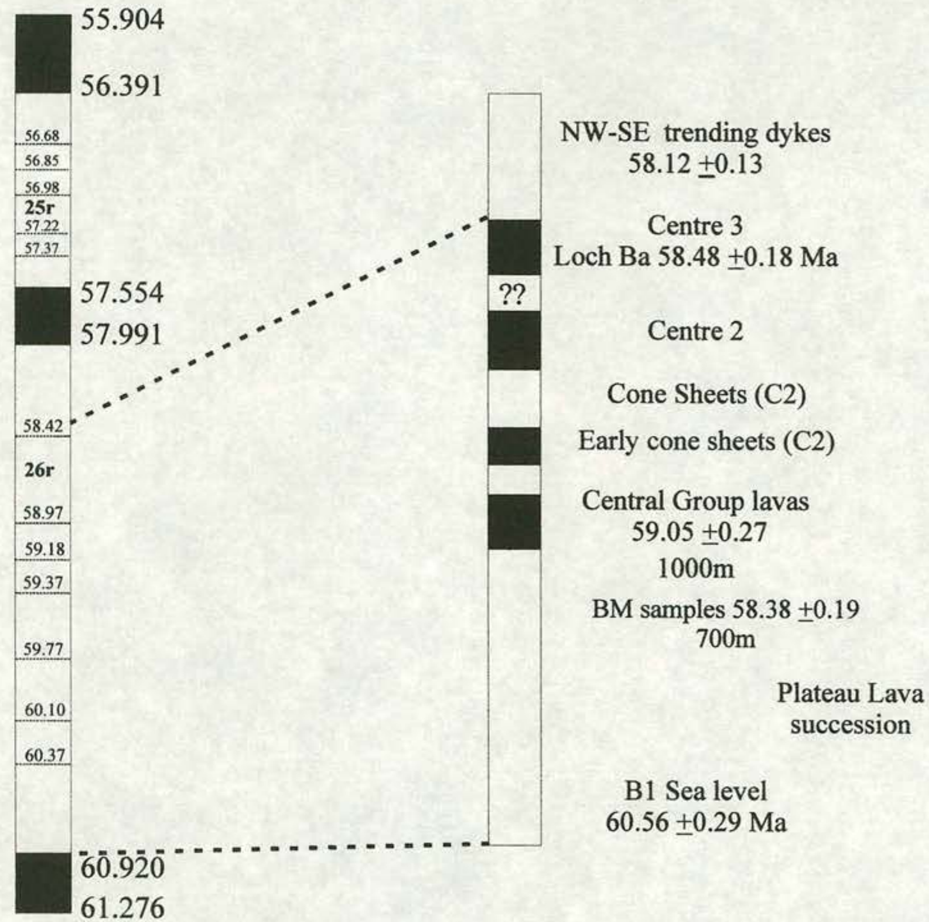


Figure 5.4. New $^{40}Ar/^{39}Ar$ dates for Mull (Chapter 4) tie the stratigraphy and magnetic changes to the geomagnetic timescale of Berggren *et al.* (1995). All of the igneous activity in Mull occurs within the reversed Chron 26r. This includes the 3 normal polarity events shown in black. The stratigraphy is taken from Emeleus and Gyopari (1992) and the magnetic data from Dagley *et al.* (1987). A short reversal between Centres 2 and 3 may not have been recorded in Mull.

The stratigraphic succession taken from Emeleus and Gyopari (1992) of Arran			Polarity	Radiometric age (Ma)	Age Reference
Dykes			R & N		
Central Igneous complex					
Granite		Tholeiitic dolerite	R		
Diorite		Analcite olivine dolerite	R		
Felsite		Olivine dolerite	R		
Explosion breccia		Pitchstone	R		
Felsite		Felsite = Quartz dolerite	R		
Gabbros			R		
Crinanite sills			R		
Northern granite					
Inner granite		Analcite olivine dolerite	N		
Outer granite		Olivine dolerite	N	57.85 $\pm$0.15	This thesis
		Tholeiitic dolerite = quartz pophyry			
		Composite quartz porphyry sills etc	N		
Olivine dolerite	Tholeiitic dolerite		R		
		Ailsa Craig Microgranite = Holy Island trachyte	R		

Table 5.4. A summary of the magmatic history, magnetic polarity and radiometric age for the Isle of Arran. The magmatic history is taken from Emeleus and Gyopari (1992), magnetic polarity from Dagley and Mussett (1978) and Hodgson *et al.* (1990). The $^{40}Ar/^{39}Ar$ age of 57.85 ±0.15 Ma is taken from this thesis. The igneous sequence in Arran records a magnetic history of R-N-R.

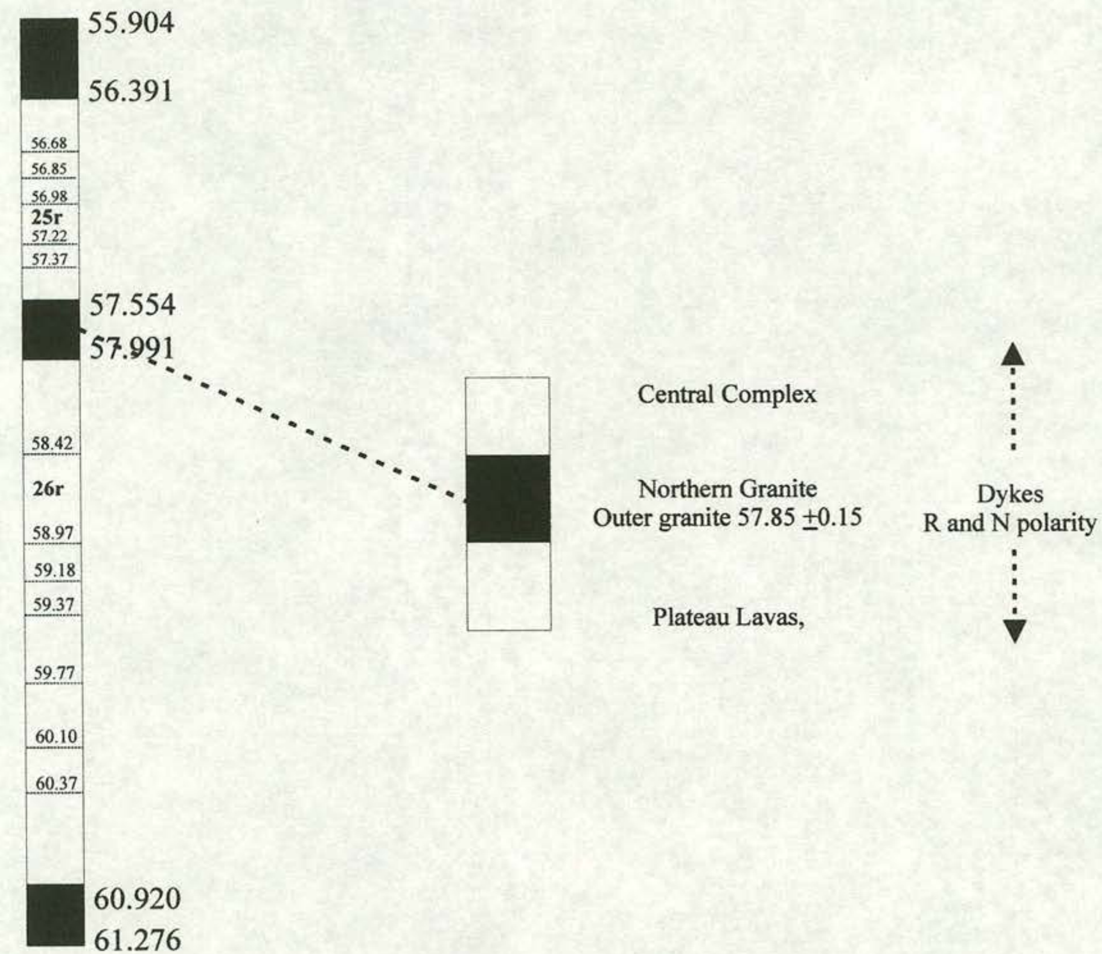


Figure 5.5. The changes in magnetic polarity seen in Arran are tied to the timescale of Berggren *et al.* (1995) using the new $^{40}Ar/^{39}Ar$ age for the north Arran granite (57.85 ±0.15 Ma). This age corresponds to Chron 26n.

The stratigraphic succession taken from Emeleus and Gyopari (1992) for Ardnamurchan, and is based on Richey and Thomas (1930) and Emeleus (1982)	Polarity	Radiometric age (Ma)	Age Reference
Late NNW-trending dolerite dykes.			
Centre 3			
Quartz monzonite	R		
Tonalite	R		
Fluxion biotite gabbro of Glendrain	R		
Fluxion biotite gabbro of Sithean Mor	R		
Quartz-biotite gabbro	R	58.82 ±0.16	This thesis
Quartz-dolerite, granophyre veined	R		
Inner eucrite	R		
Biotite eucrite	R		
Quartz gabbro, southern side of Meall an Tarmachain	R		
Quartz gabbro of Meall an Tarmachain summit	R		
Outer eucrite	R		
Great eucrite	R		
Cone-sheets of Centre 3	R		
Porphyritic gabbro of Meall nan Con screen	R		
Gabbro, south east of Rudha Groulin	R		
Gabbro of Plochaig	R		
Fluxion gabbro of Faskadale	R		
Quartz gabbro of Faskadale	R		
Centre 2 (Migration of focus of activity to Achnaha area)			
Felsite, south of Aodann			
Fluxion gabbro of Portuairk	R		
Younger quartz gabbro of Beinn Bhuidhe			
Quartz gabbro of Beinn na Seilg	R		
Quartz gabbro of Loch Caorach	R		
Eucrite of Beinn nan Ord	R		
Inner cone-sheets of Centre 2	R		
Quartz dolerite of Sgurr nam Meann	R		
Quartz gabbro of Aodann			
Older quartz gabbro of Beinn Bhuidhe	R		
Granophyre of Grigdale	R		
Quartz gabbro of Garbh-dhail			
Old gabbro of Lochan an Aodainn	R		
Hypersthene gabbro of Ardnamurchan point	R		
Glas Eileen vent			
Outer cone sheets of Centre 2	R		
Centre 1 and the Ben Hiant vent (some stratigraphic relationships uncertain) (migration of focus of activity to Aodann area [NM 543 664])			
Cone-sheets of Centre 1 (penecontemporaneous with the quartz dolerite intrusion of Ben Hiant)	R	59.14 ±0.19	This thesis
Ben hiant quartz dolerite	R		
Composite intrusion of Beinn an Leathaid			
Augite dolerite of Camphouse	R		
Quartz dolerite of Camphouse	R		
Porphyritic dolerite of Ben haint	R		
Granophyre west of Faskadale	R		
Old gabbro of Meall nan Con	R		
Porphyritic dolerite of Glas Bheinn			
Agglomerates of Northern vents			
Tuffs, agglomerates and lavas of Ben Hiant vents			
Trachyte plug	R		
(Igneous activity localised at Ben Hiant and also centred on a focus ~ 1.3 km west of Meall nan Con)			
Palaeocene basalt lavas and thin sediments	R		

Table 5.5. The complex igneous history of Ardnamurchan (Emeleus and Gyopari, 1992), and the magnetic polarity data of Dagley *et al.* (1984) are summarised here. The $^{40}Ar/^{39}Ar$ ages for Ardnamurchan obtained as part of this study are also shown.

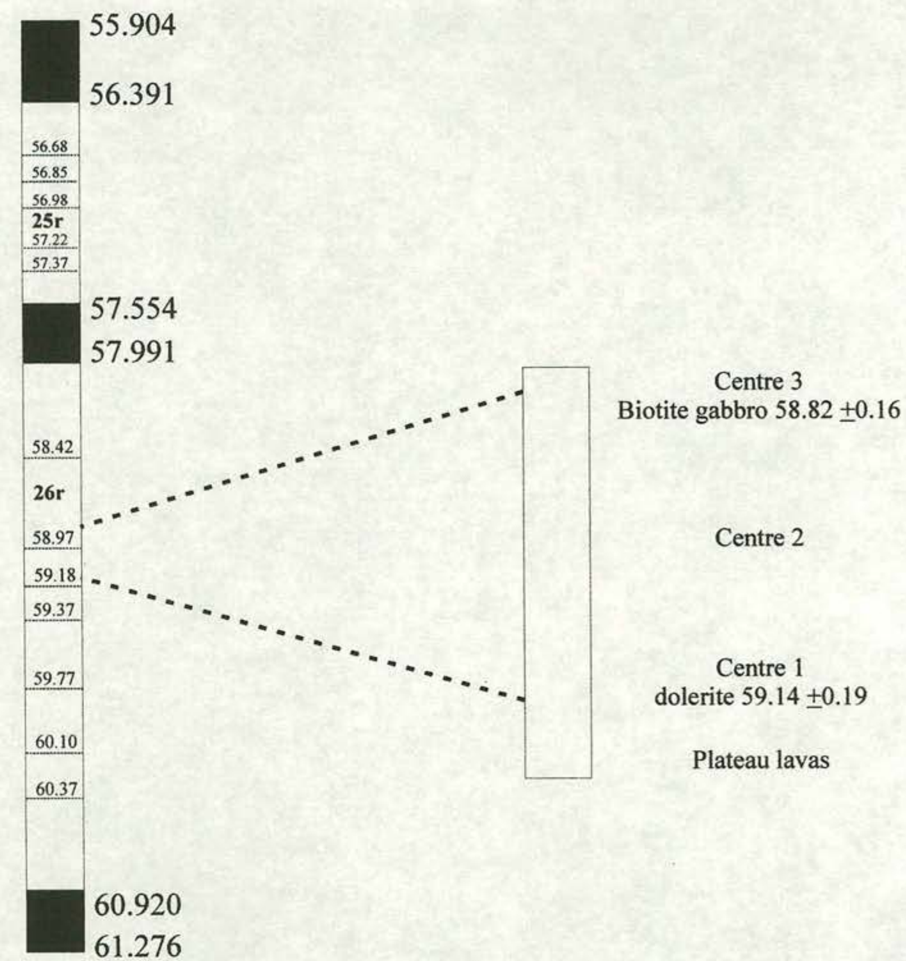


Figure 5.6. The rocks of the Tertiary igneous centre of Ardnamurchan all have reversed magnetic polarity (Dagley *et al.*, 1984). Using the new $^{40}Ar/^{39}Ar$ ages this occurred within the reversed Chron 26r (Berggren *et al.*, 1995).

The stratigraphic succession taken from Wallace (1995) and Gamble *et al* (1999)	Polarity	Radiometric age (Ma)	Age Reference
Carlingford	R	60.9 ±0.5	Thompson 1986
Slieve Gullion	R	56.5 ±1.3	Gamble *et al*, 1999
Mourne G5	R (apart from an acid vein and dyke)	54.6 ±1.0	Gibson *et al*, 1995
Mourne G4	R	56.0 ±0.6	Gibson *et al*, 1995
Mourne G3	R	56.4 ±0.1	Gibson *et al*, 1995
Mourne G2	R	54.9 ±1.2	Thompson *et al*, 1987
Mourne G1	R	55.47 ±0.11	This thesis
Upper Basalts	R	58.79 ±0.35 (AGH4)	This thesis
Interbasaltic			
Causeway Tholeiite Member	R	60.35 ±0.74	This thesis
Sandy Breas obsidian	R	60.16 ±0.09 (sanidine), 59.62 ±0.26 (glass)	This thesis
Tardree rhyolite	R	60.00 ±0.08	This thesis
Lower Basalts	R	61.02 ±0.08	This thesis

Table 5.6. The Antrim plateau basalts are subdivided into Lower, Middle and Upper Formations. The Middle or Interbasaltic Formation includes the Sandy Braes obsidian and the Tardree rhyolite. The Mourne Mountains, Carlingford and Slieve Gullion central complexes are also included. All of the Tertiary rocks have reversed magnetic polarity (Wilson, 1970; Mussett *et al.*, 1988), apart from a vein and a dyke that cut the Mourne Mountains granite number 5.

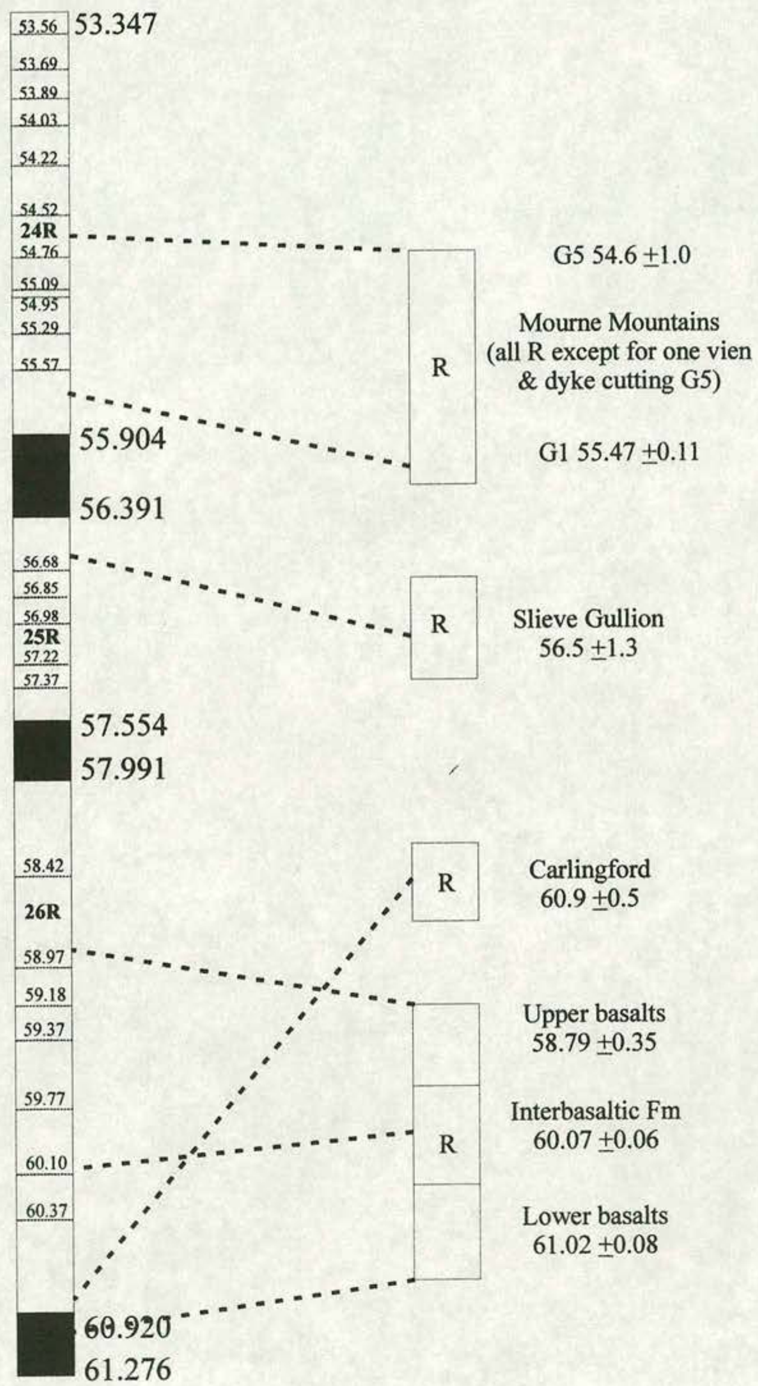


Figure 5.7. Radiometric ages from this study, Gibson *et al.* (1995), Gamble *et al.* (1999) and Thompson (1986) are used to correlate the magmatic history of Antrim to the geomagnetic timescale of Berggren *et al.* (1995). $^{40}Ar/^{39}Ar$ ages for the Lower basalts correlate to within Chron 27n. The lower basalts have reversed polarity, which means they could correlate to Chron 26r or Chron 27r. As no lava flows with normal polarity have been found in Antrim, the Lower basalts have been correlated to the base of Chron 26r.

Sample	Location	Depth	Latitude	Longitude	Age (Ma)	Polarity	Pol. Ref.
HTS	Hebrides Terrace				Pre 60.0		
57-12/18	Anton Dohrn	3.42 m	57 33.62	11 05.87	54.03 ±0.17(This thesis)		
57-13/66	Rockall	0.80-0.85 m	57 21.28	12 57.81	57.03 ±0.21 (This thesis)		
57-14/53	Rockall	0.80-0.85 m	57 34.14	13 19.80	56.5+/-0.1	R	KB
58-14/42	George Bligh Bank	4.55-4.6 m	58 57.72	13 45.45	No age		
58-14/50	Rockall		58 04.13	13 20.45	No age		
59-11/12A	Rosemary Bank	1.10 m	59 18.41	10 04.99	Late Maastrictian (Pre 65)	R	KB
59-11/12B	Rosemary Bank	3.0 m	59 18.41	10 04.99	Late Maastrictian (Pre 65)	R	KB
85/5B	Hebrides Shelf	42.60 m	58 28.77	7 52.35	42.6	R	SC
85/7	Hebrides Shelf	30.37 m	59 23.23	6 23.55	57.5	N	SC
88/10	Hebrides Shelf	132.85 m	58 58.23	6 57.05	Pre 53.1+/-0.5		
90/4	Hebrides Shelf	14.9 m	59 22.08	6 21.26	46.4+/-2.8		
90/7	Hebrides Shelf	10.4 m	58 28.15	7 38.16	62.4+/-1.3	N	SC
90/10	Hebrides Shelf	9.20 m	58 07.94	8 05.66	55.8+/-0.7 or 54.4+/-0.7	R	SC
90/18	Rosemary Bank	39.65 m	59 14.97	10 10.04	Post 55.0		
163A	NE Rosemary Bank	3535 m			Post 55.0		
163B	NE Rosemary Bank	3594.5 m			Post 55.0		
94/2	Rockall (s)	22.15 m	56 54.24	13 34.51	Pre 55.5-44.0	N	KB
94/3A	Rockall	47.3 cms?	57 10.74	13 12.52	Pre 55.0	R	KB
94/3B	Rockall	209.65 m	57 10.74	14 12.52	Pre 55.0	R	KB
94/5	Rockall	29.96 m	57 30.19	13 09.14	Post 56.5+/-0.1	R	KB
94/6	Rockall (n)	21.1 m	58 13.05	13 33.05	61-55	R	KB
94/7	George Bligh Bank	22.65 m	58 56.42	13 14.64	Pre 56	R	KB
HTN	Hebrides Terrace north	dredge			Pre 60		

Table 5.7. The location of the samples collected by the British Geological Survey and the magnetic polarity of the samples (K. Banister, 1995; S. Carter, 1994). Ages are from BGS biostratigraphic reports, this thesis or taken from Richie and Hitchen (1996).

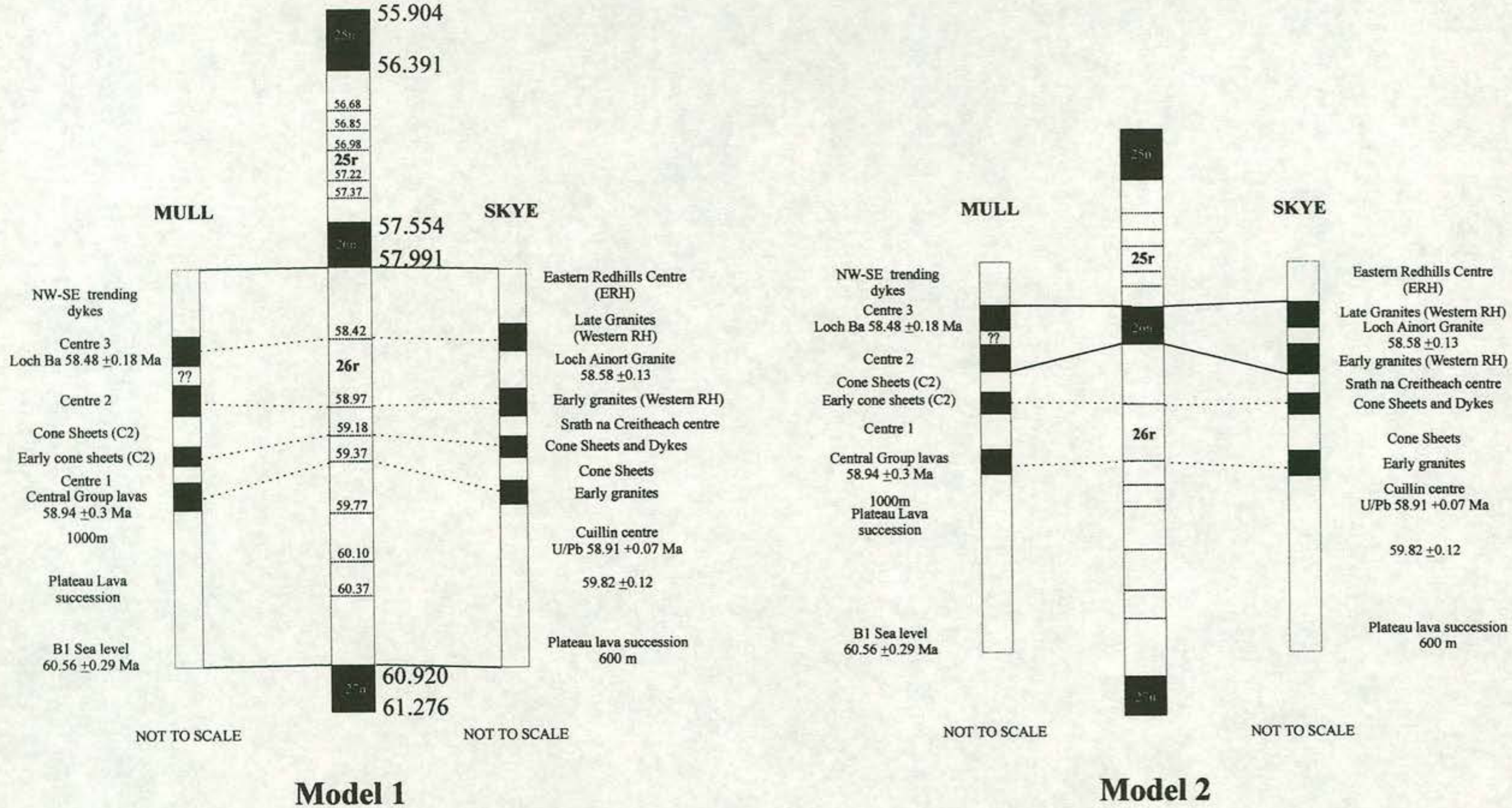


Figure 5.8. Two models showing the possible correlations of Skye and Mull to the geomagnetic timescale of Berggren *et al.* (1995), taken from Chambers and Pringle (submitted b). Model 1 shows the normal polarity events from Skye and Mull, now known from the $^{40}Ar/^{39}Ar$ ages to occur within Chron 26r, correlated to cryptochrons within Chron 26r. The position of cryptochrons is taken from Cande and Kent (1995). Model 2 shows the possible older position of Chron 26n now correlating to the large normal events of Centres 2 and 3 in Mull. The earlier normal events still require the existence of cryptochrons within Chron 26r. As cryptochrons are only up to 30 kyr in duration, this model (2) is easier to reconcile with the large number of intrusions seen within Centres 2 and 3.

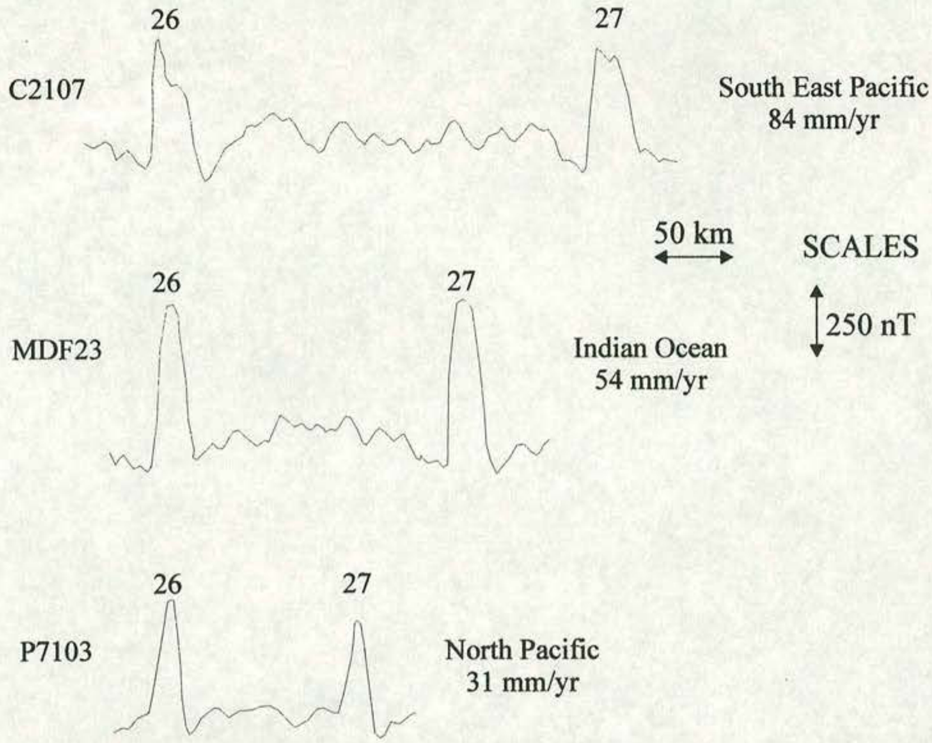


Figure 5.9. Seafloor magnetic profiles from the Pacific and Indian oceans between Chron 26n and Chron 27n, redrawn from Cande and Kent (1992b). The faster spreading South East Pacific better resolves the tiny wiggles during Chron 26r. These wiggles correspond to the seven cryptochrons of Chron 26r in Cande and Kent (1992a). The normal events of Chrons 26n and 27n also show tiny wiggles that may be reversed cryptochrons.

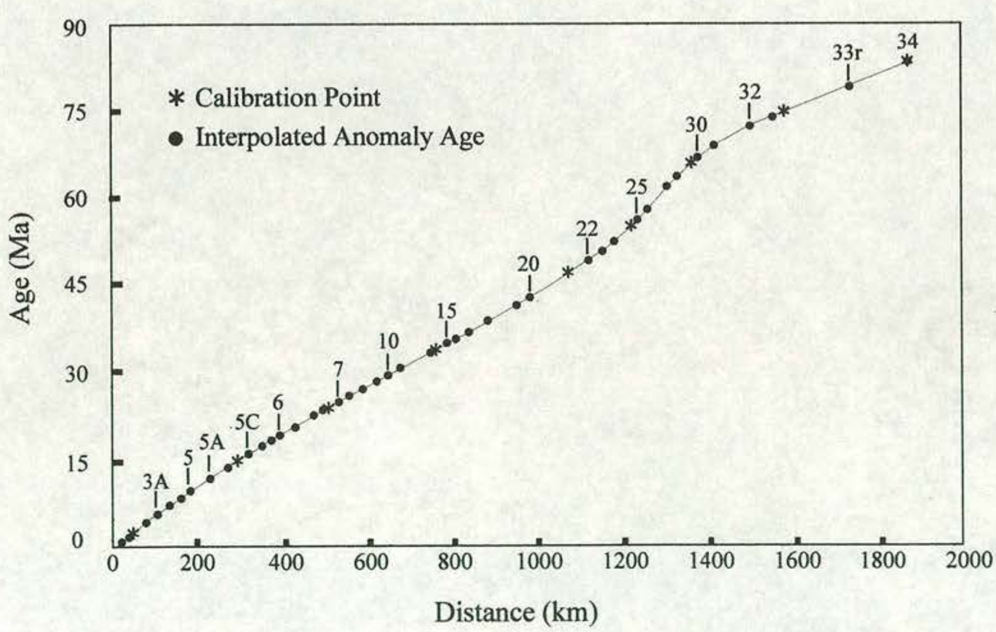


Figure 5.10. Calibration points and magnetic anomalies are shown on a distance versus age plot, redrawn from Cande and Kent (1992b). Between the calibration points the position of magnetic anomalies are interpolated using constant seafloor spreading rates.

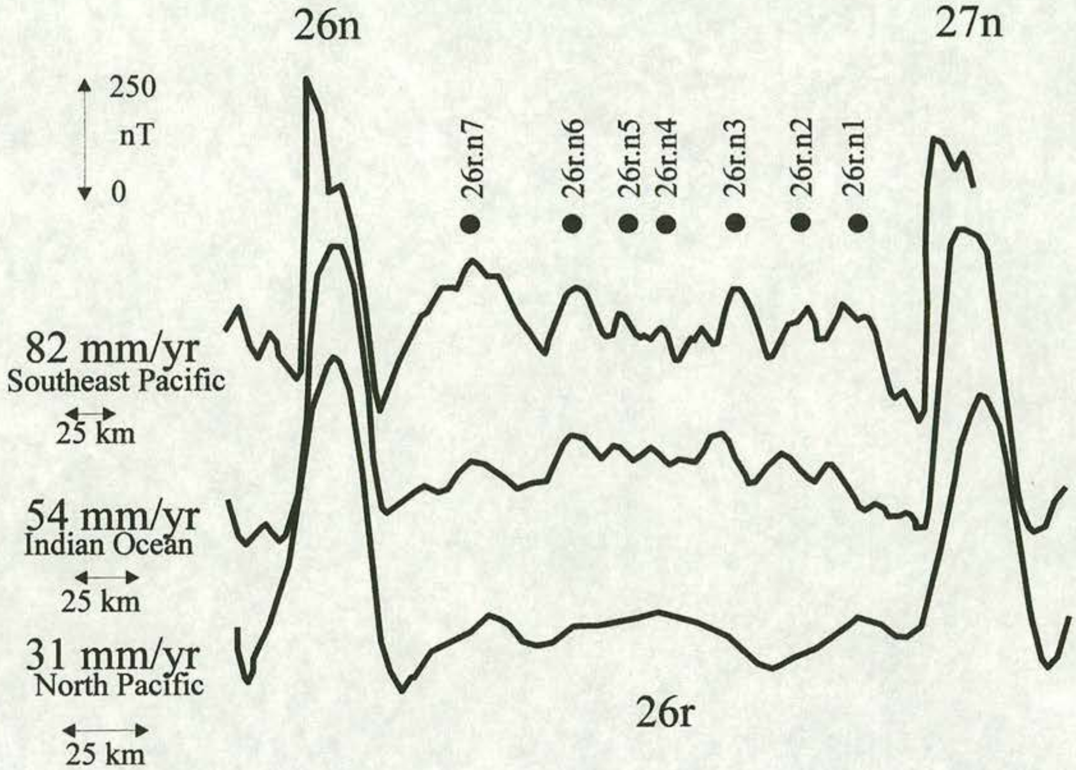


Figure 5.11. Comparison of the pattern of tiny wiggles in three seafloor spreading records that have been stretched to a common width, redrawn from Cande and Kent (1992b). The position of the seven cryptochrons within Chron 26r are shown as black dots.

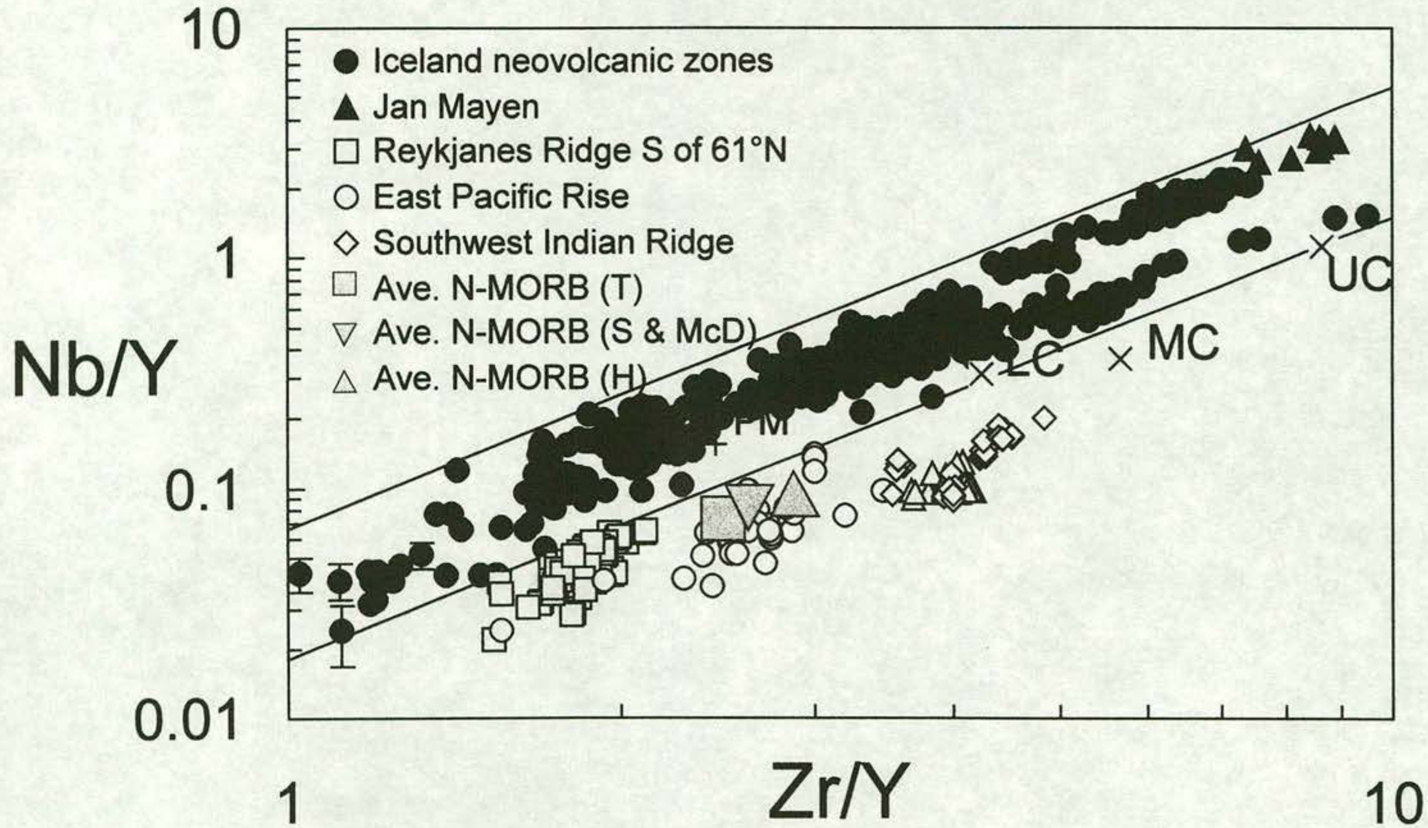


Figure 6.1. Zr/Y and Nb/Y variation in basalts from the neovolcanic zone in Iceland and normal segments of mid-ocean ridge (Fitton *et al.*, 1997). The two lines enclose the Iceland array. PM = Primitive mantle (McDonough and Sun, 1995). Average values of upper, middle and lower crust (Rudnick and Fountain, 1995) plot close to the lower boundary line of the Iceland array. Average values of N-MORB are also shown (Hofmann, 1988; Sun and McDonough, 1989). ΔNb is the distance in log units from the lower boundary line of the Iceland array.

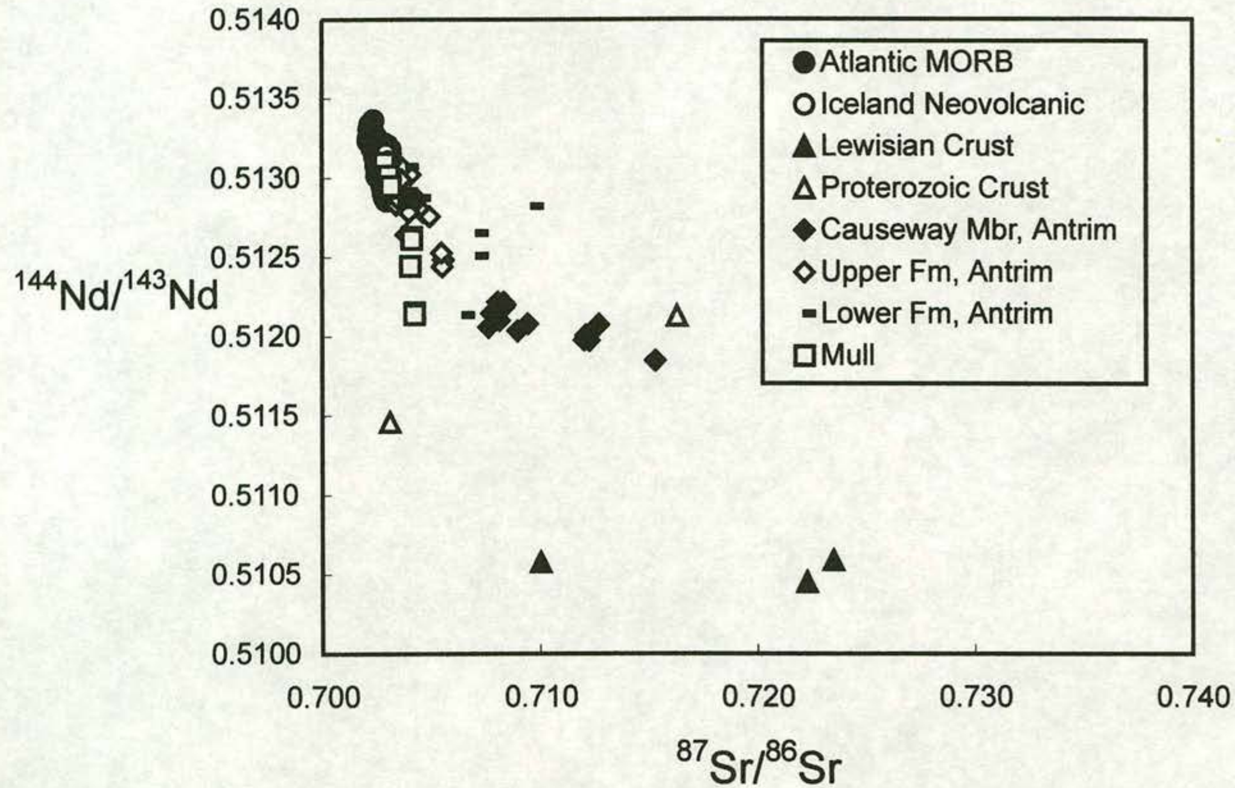


Figure 6.2. Variation in $^{87}Sr/^{86}Sr$ and $^{143}Nd/^{144}Nd$ in lavas from the Iceland neovolcanic zone (Hardarson *et al.*, 1997), North Atlantic MORB (Taylor *et al.*, 1997), and the BTIP (Kerr, 1993; Wallace *et al.*, 1994; Barrat and Nesbitt, 1996). Lewisian and Proterozoic crust samples are also plotted (Kerr *et al.*, 1995; Dickin and Bowes, 1991; Marcantonio *et al.*, 1988). The BTIP samples form trends between the uncontaminated Atlantic MORB and Iceland fields and the crustal contaminants.

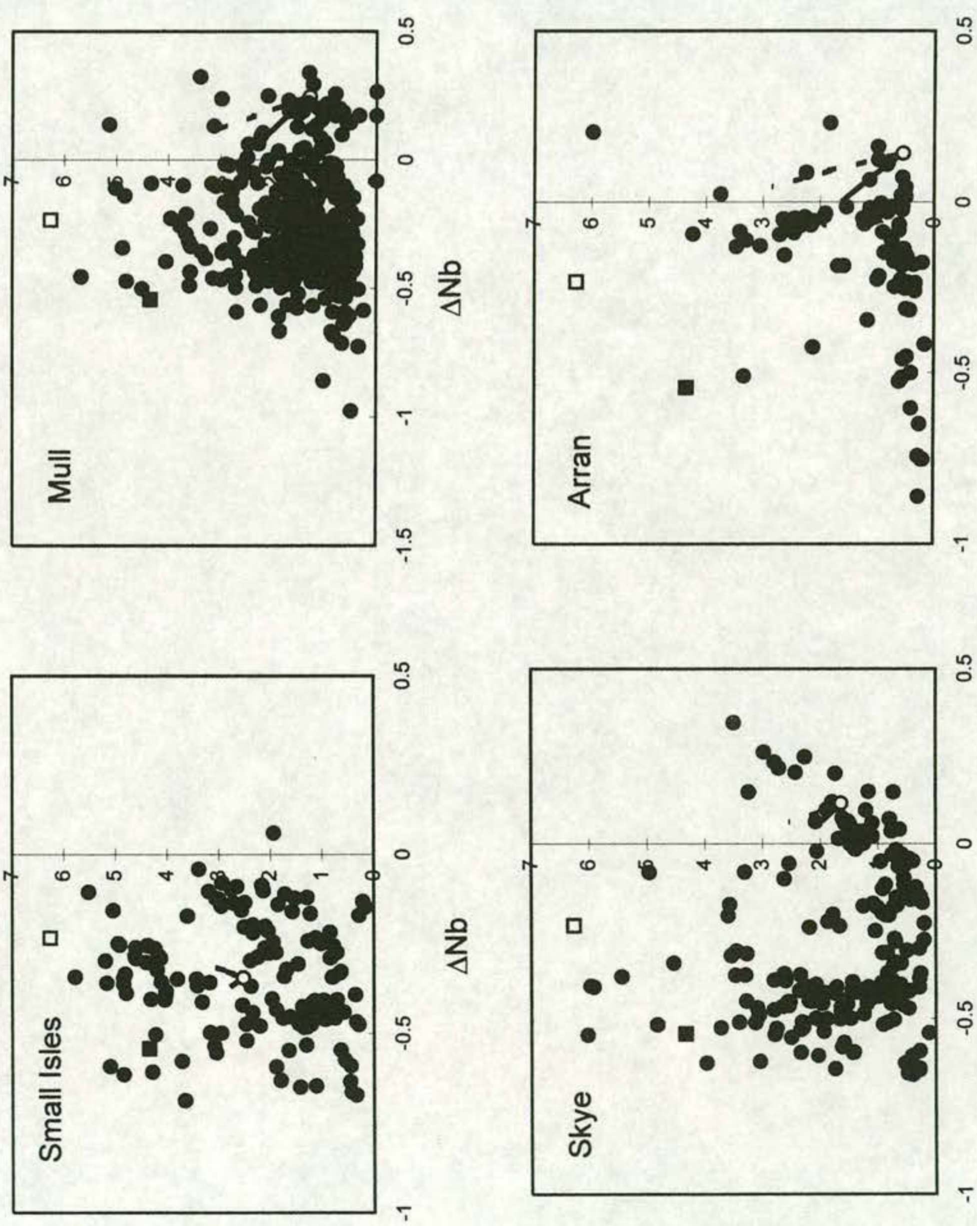


Figure 7.5. Variations in Ba/Zr with ΔNb in Mull, Skye, the Small Isles and Arran. An average basalt (open circle) for each area is plotted with lines representing the addition of 20% crust. Average values of Moine pelite (open square) and Lewisian granulite (solid square) are shown. The addition of up to 20% crust does not change the value of significantly.

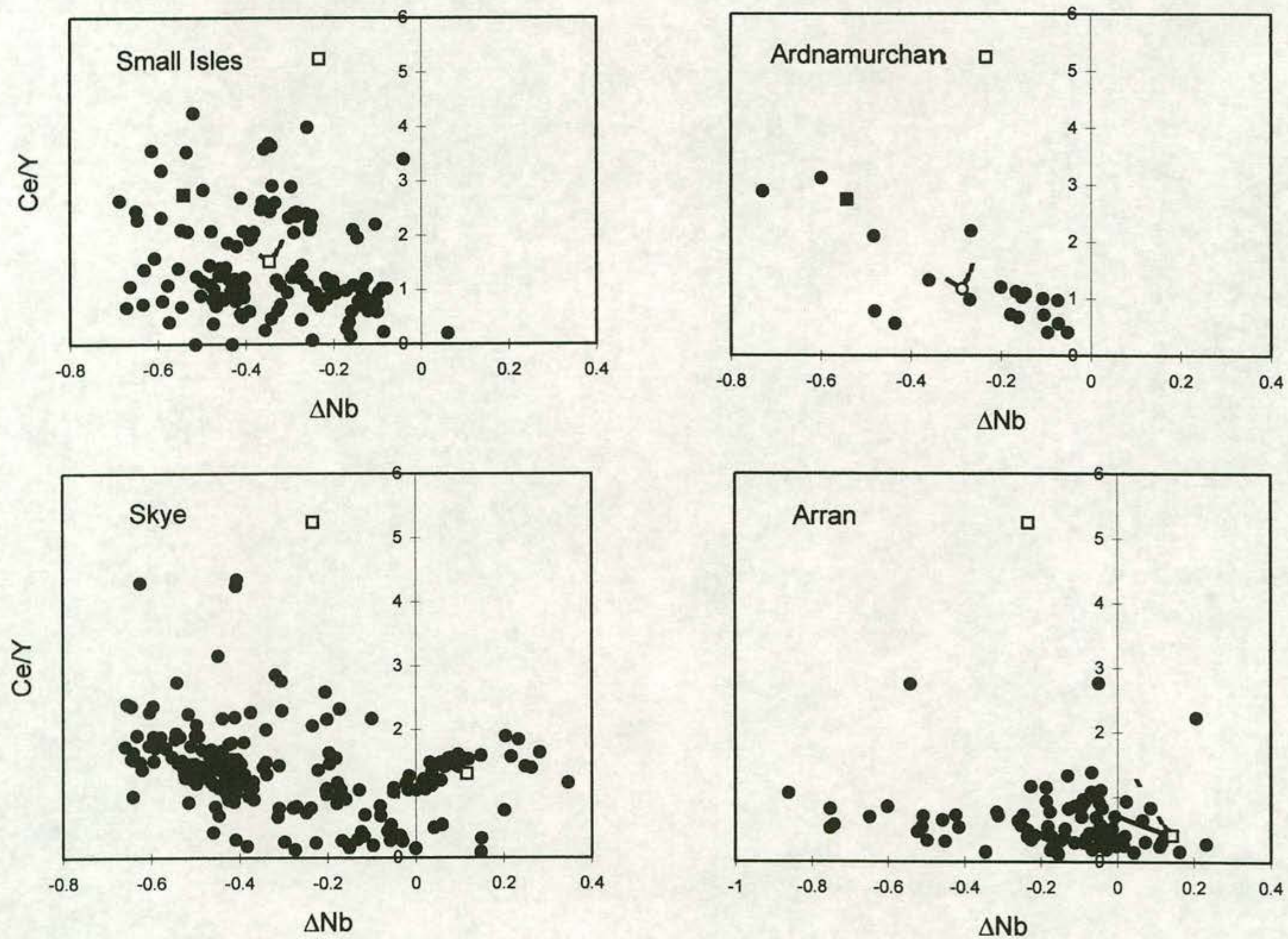


Figure 6.4. Variation in Ce/Y and ΔNb in lavas from the Small Isles, Ardnamurchan, Skye and Arran. Average basalts (open circle) with positive ΔNb and negative ΔNb (Small Isles) are shown with lines representing mixing of the average sample with 20% crust (Moine = open square; Lewisian = closed square). Ardnamurchan samples show apparent mixing trends towards Lewisian granulite. The value of ΔNb does not change significantly by the addition of 20% crust.

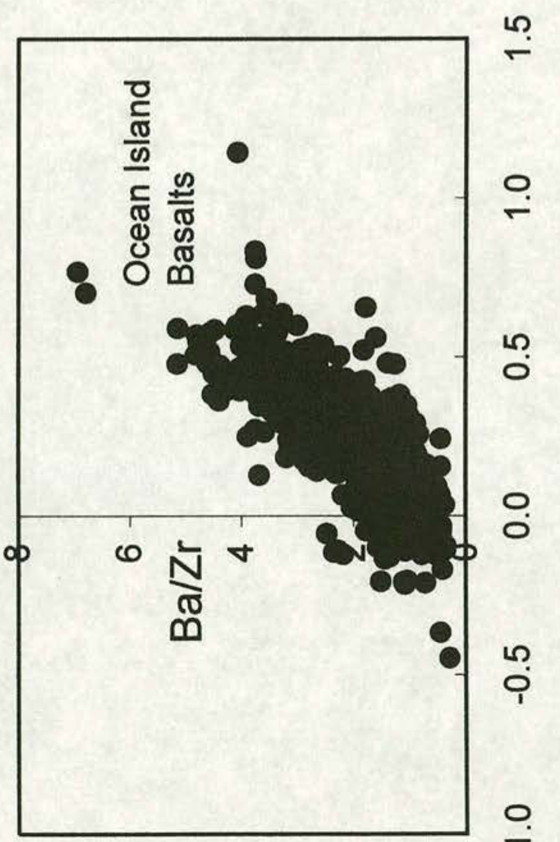


Figure 6.5. Variation in Ba/Zr and ΔNb in samples from the worlds ocean island basalts (OIB) (D. James and G. Fitton, unpublished data). OIB samples define an array similar to that seen in Skye.

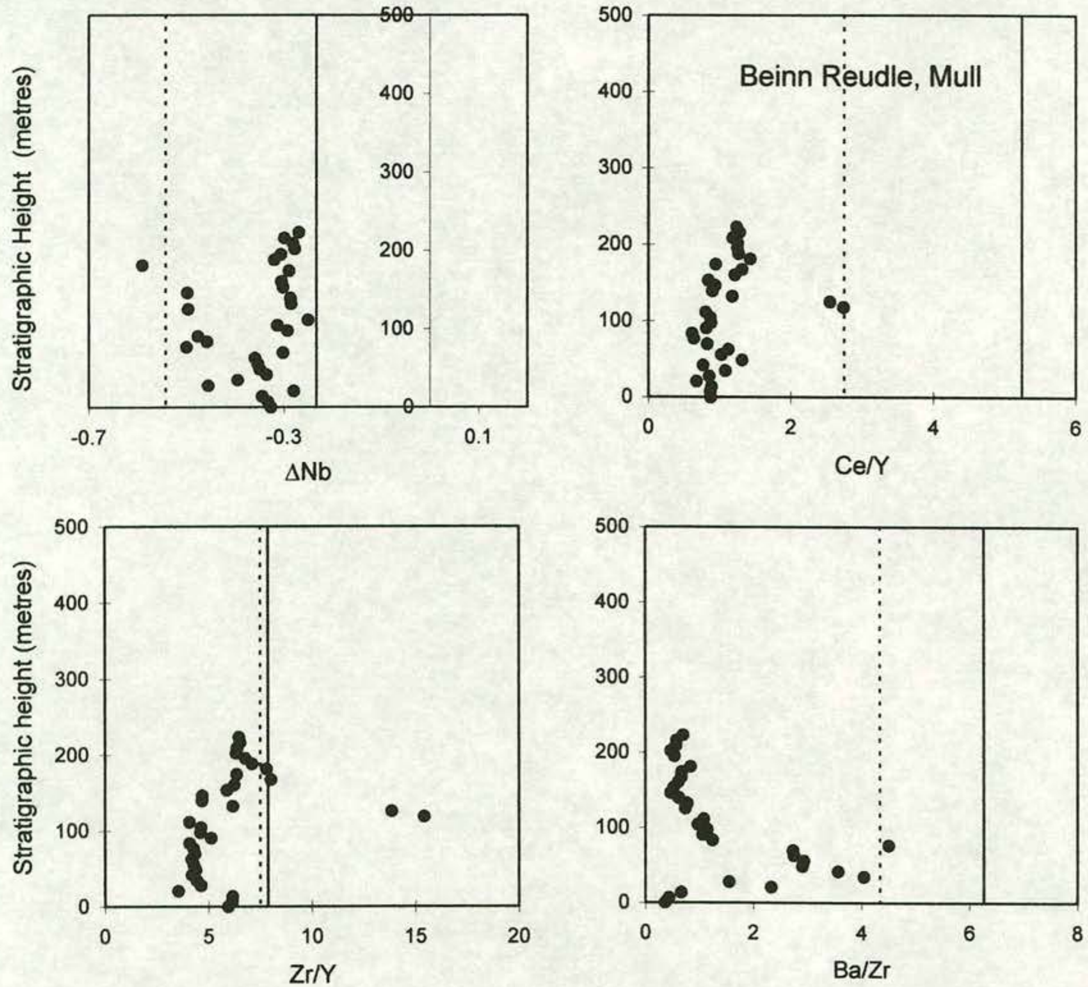


Figure 6.6. Variation in ΔNb, Zr/Y, Ba/Zr and Ce/Y with stratigraphic height in the Beinn Reudle section of Kerr (1993,1995). Values of ΔNb for Lewisian granulite (dashed line) and Moine pelite (solid line) are shown on all of the plots (Thompson *et al.*, 1986; Weaver and Tarney, 1981). Lower parts of the succession show an increase in the values of Ba/Zr towards crustal values with time, but the values of ΔNb remain almost constant. Two distinct trends in ΔNb seen above 100 m can be seen which are attributed to mixing of some of the magma with a more depleted source.

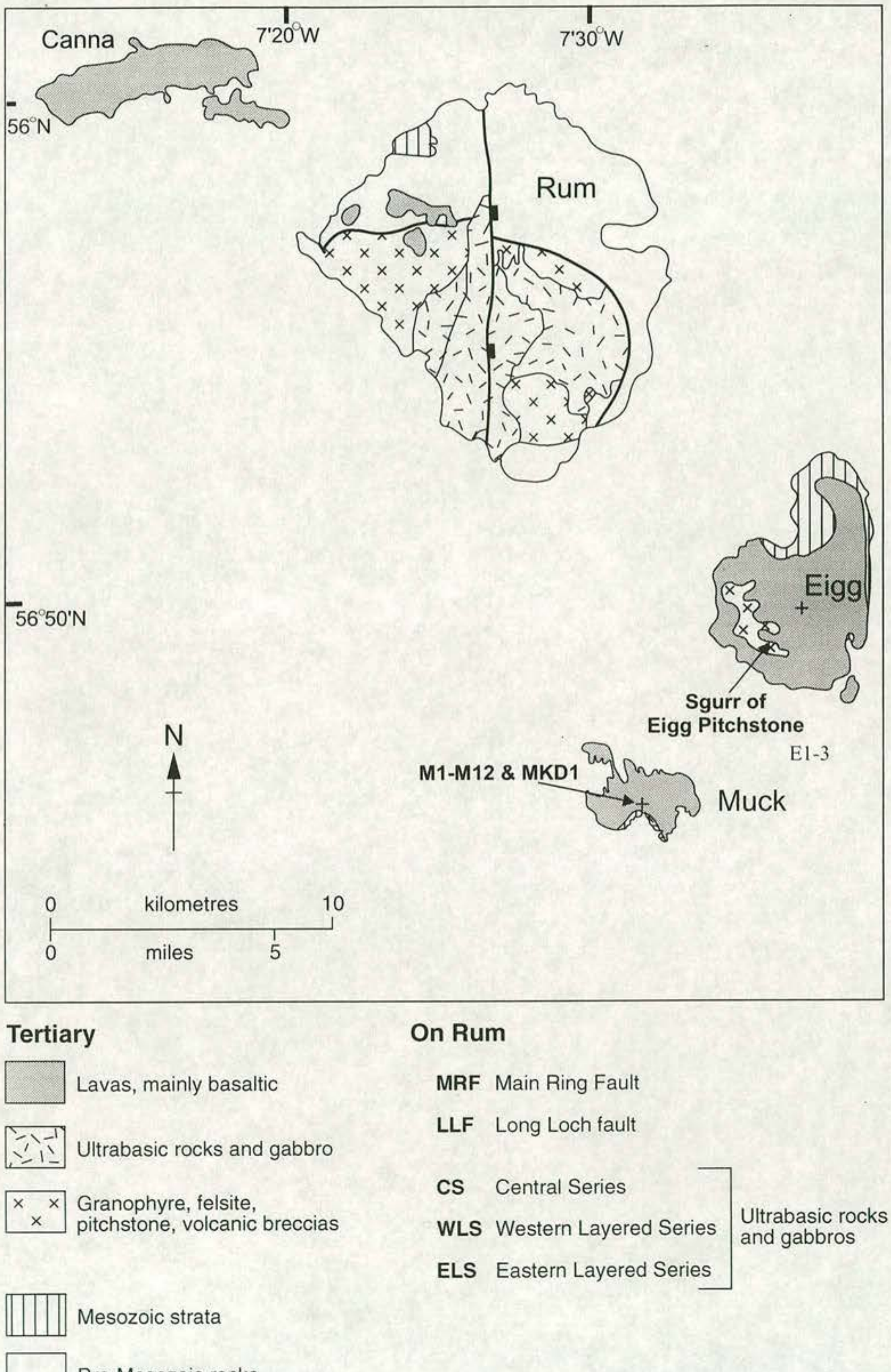


Figure 6.7. Sample localities in the Small Isles are shown on a simplified geological map, redrawn from Emeleus and Gyopari (1992).

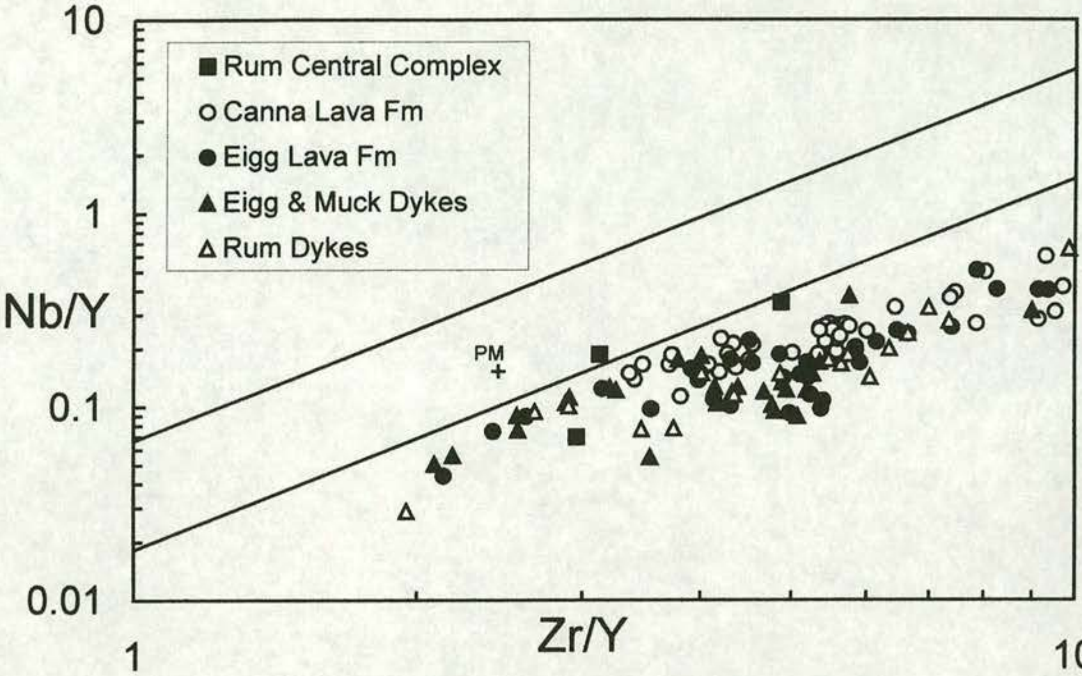


Figure 6.8. Basalts from the Small Isles samples define an array within the N-MORB field on a Zr/Y versus Nb/Y discrimination diagram. Only one sample, from the Rum central complex, has positive ΔNb.

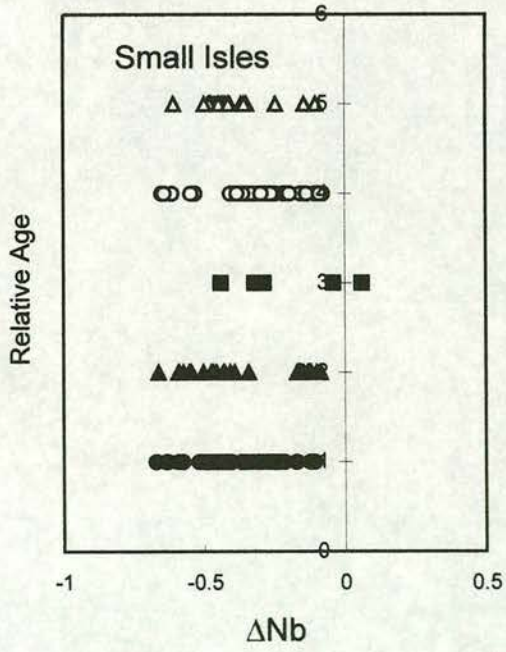


Figure 6.9. The Small Isles samples divided into 5 stratigraphic groups (see details in the text).Eigg LF = filled circles; Eigg & Muck dykes = filled triangles; Central Complex samples = filled squares; Canna LF = open circles; Canna Dykes = open traingles.

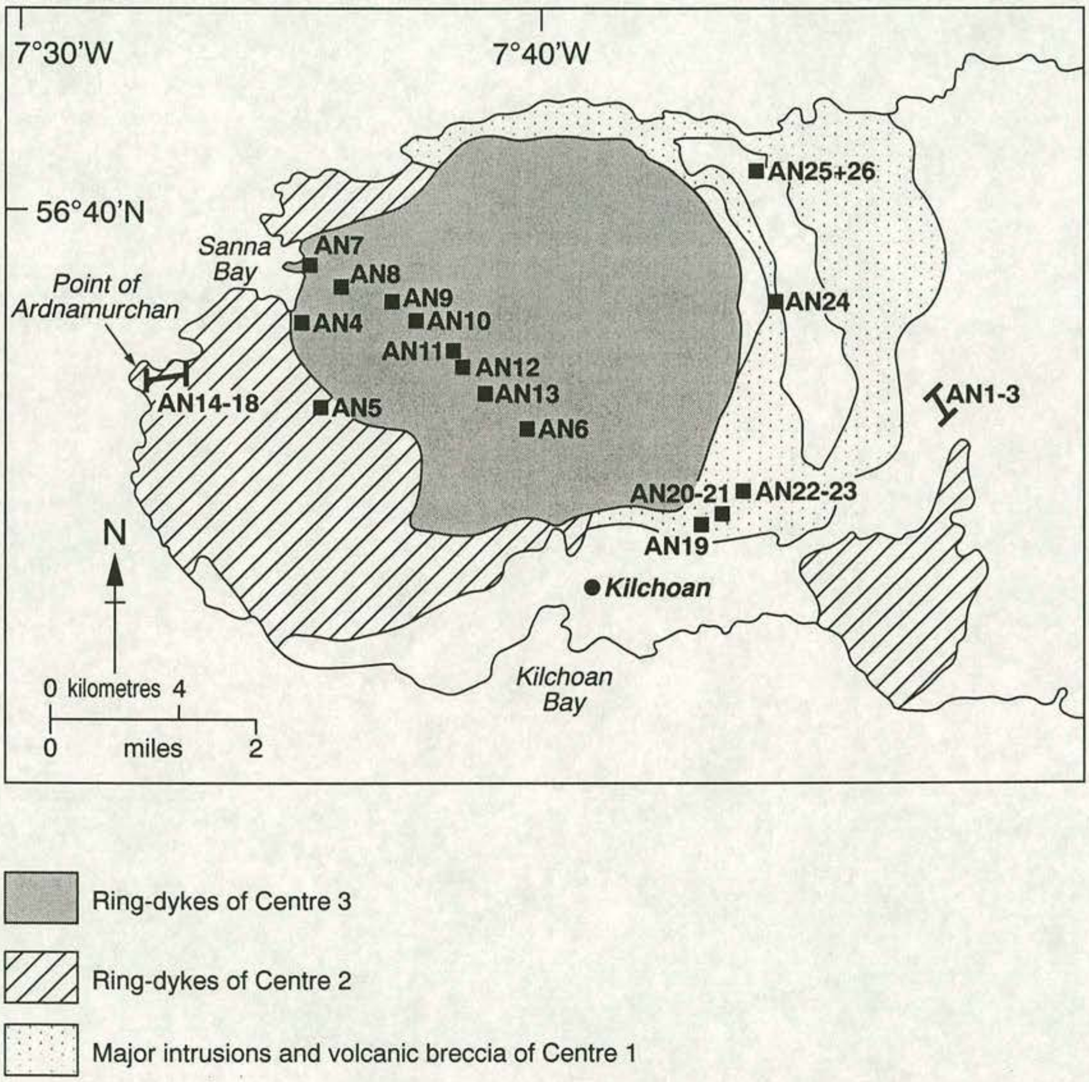


Figure 6.10. Sample localities are shown on a simplified geological map of Ardnamurchan, redrawn from Emeleus and Gyopari (1992).

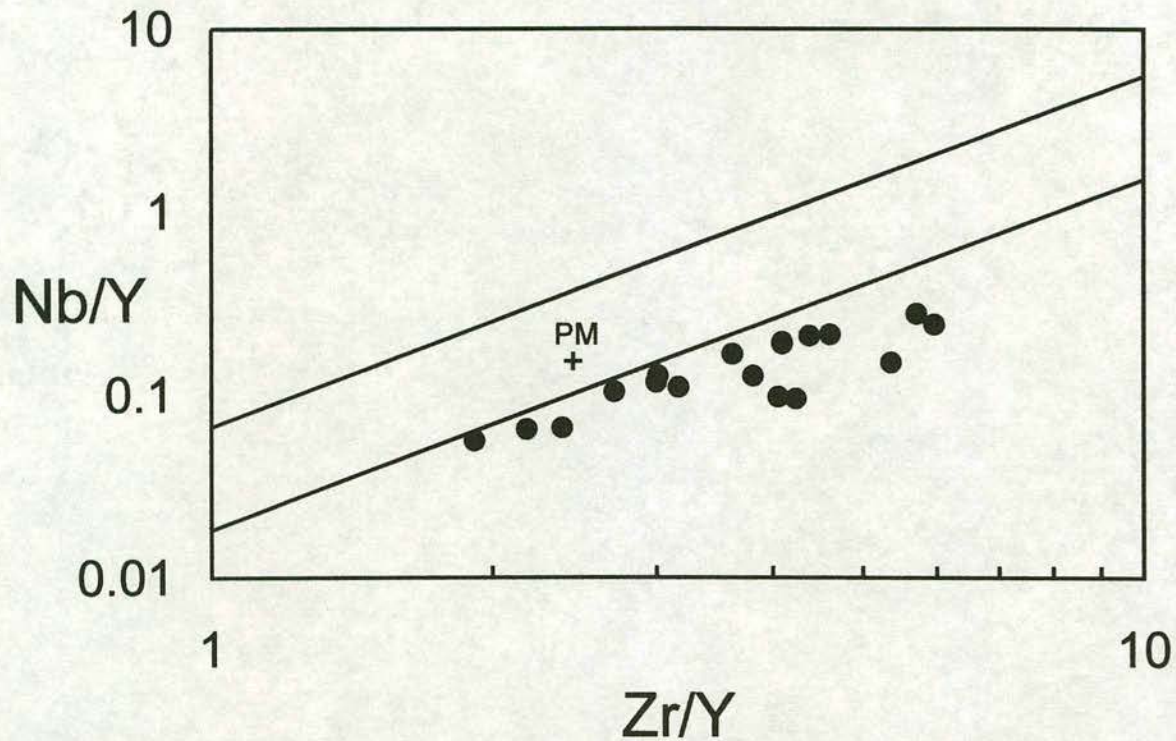


Figure 6.11. Basalt samples from Ardnamurchan plotted on a Zr/Y versus Nb/Y discrimination diagram. All of the Ardnamurchan samples, from Centres 1 to 3, define an array within the N-MORB field.

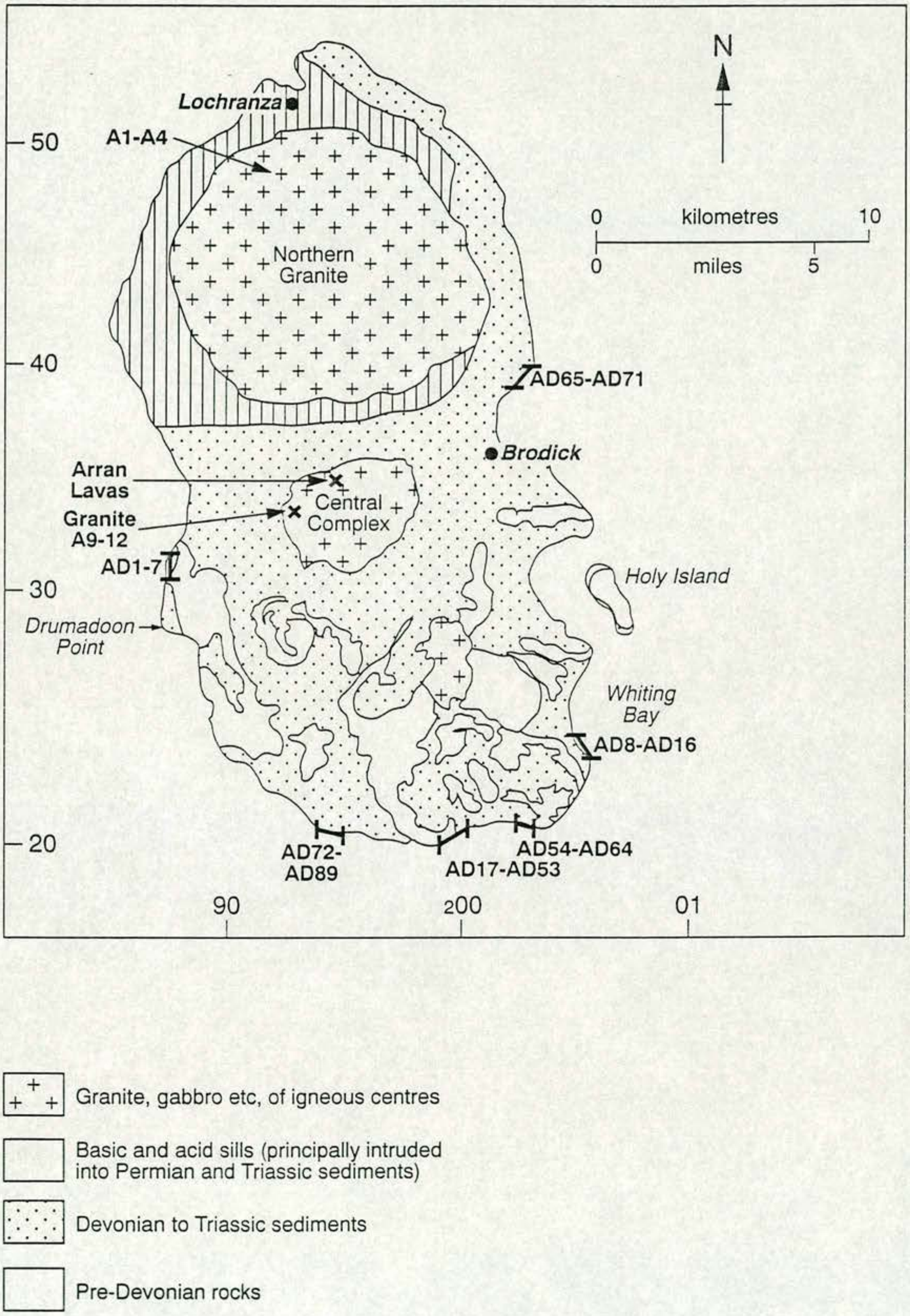


Figure 6.12. Sample localities are shown on a simplified geological map of Arran, redrawn from Emeleus and Gyopari (1992).

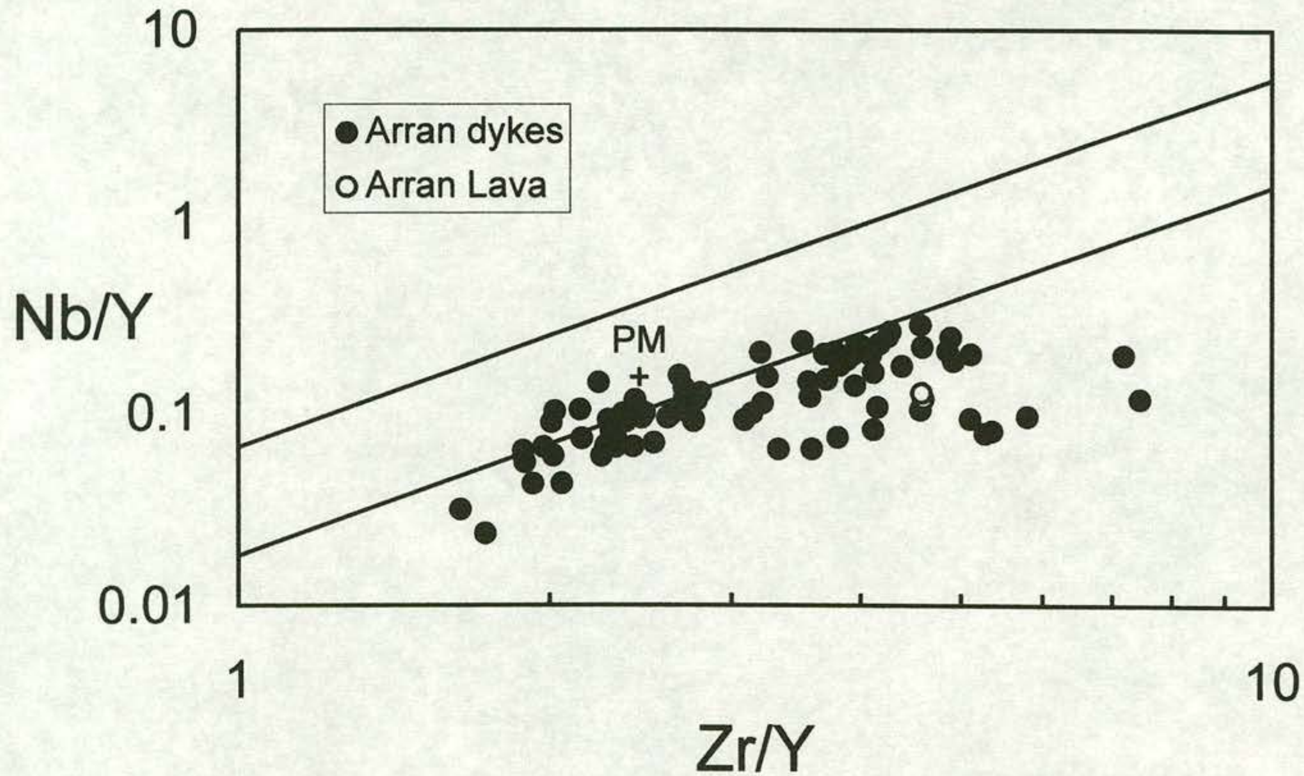


Figure 6.13. The Arran dykes plot within the Iceland and N-MORB arrays on a Zr/Y versus Nb/Y discrimination diagram. The two lava flow samples plot within the N-MORB array.

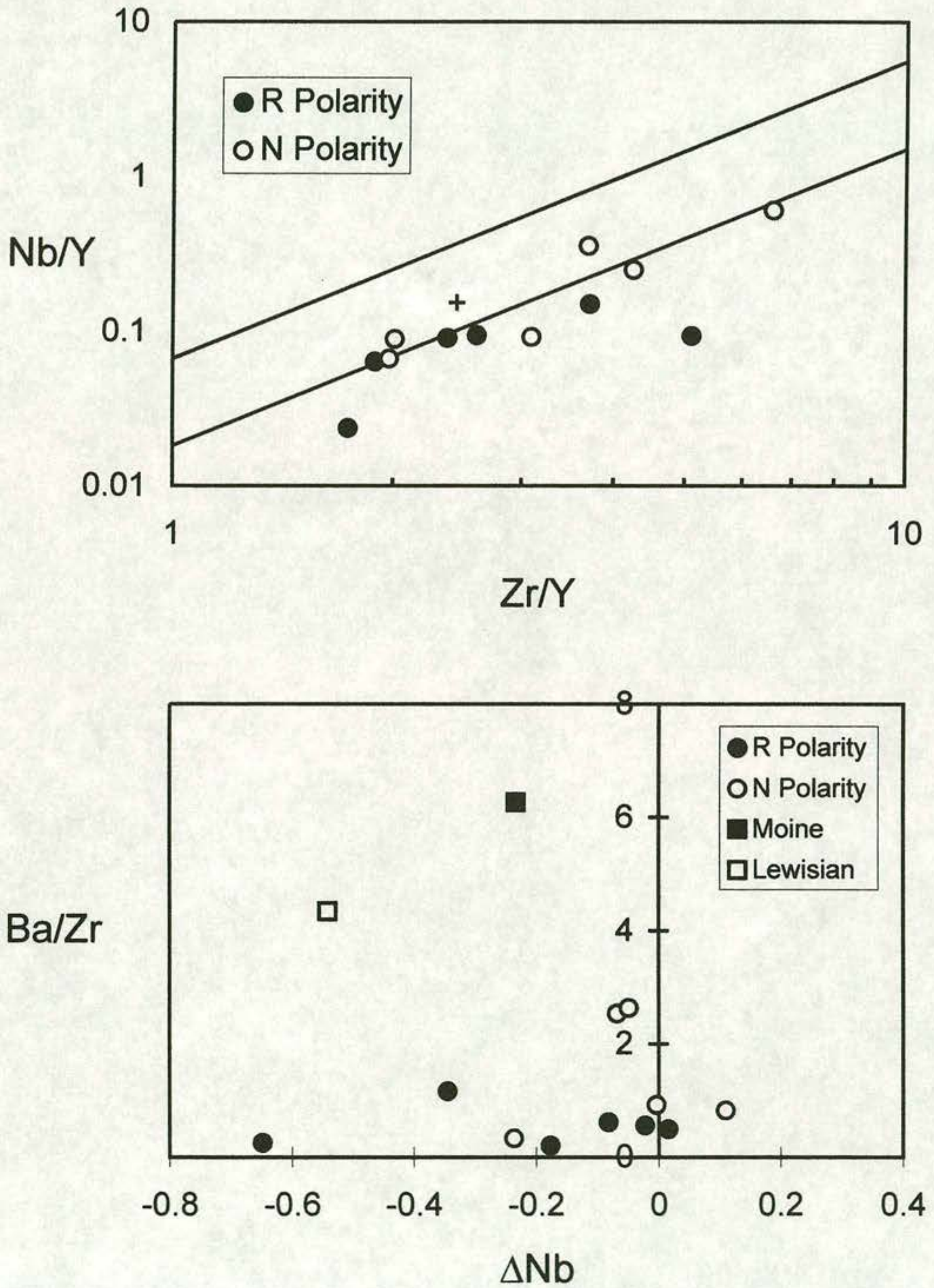


Figure 6.14. Basalt dykes with known magnetic polarity (Robertson, 1999) are shown on a Zr/Y versus Nb/Y diagram and a plot of Ba/Zr versus ΔNb. Both the normal and reversed polarity dykes within both the N-MORB and Iceland arrays. Crustal contamination does not appear to be significant in these dyke samples (low Ba/Zr).

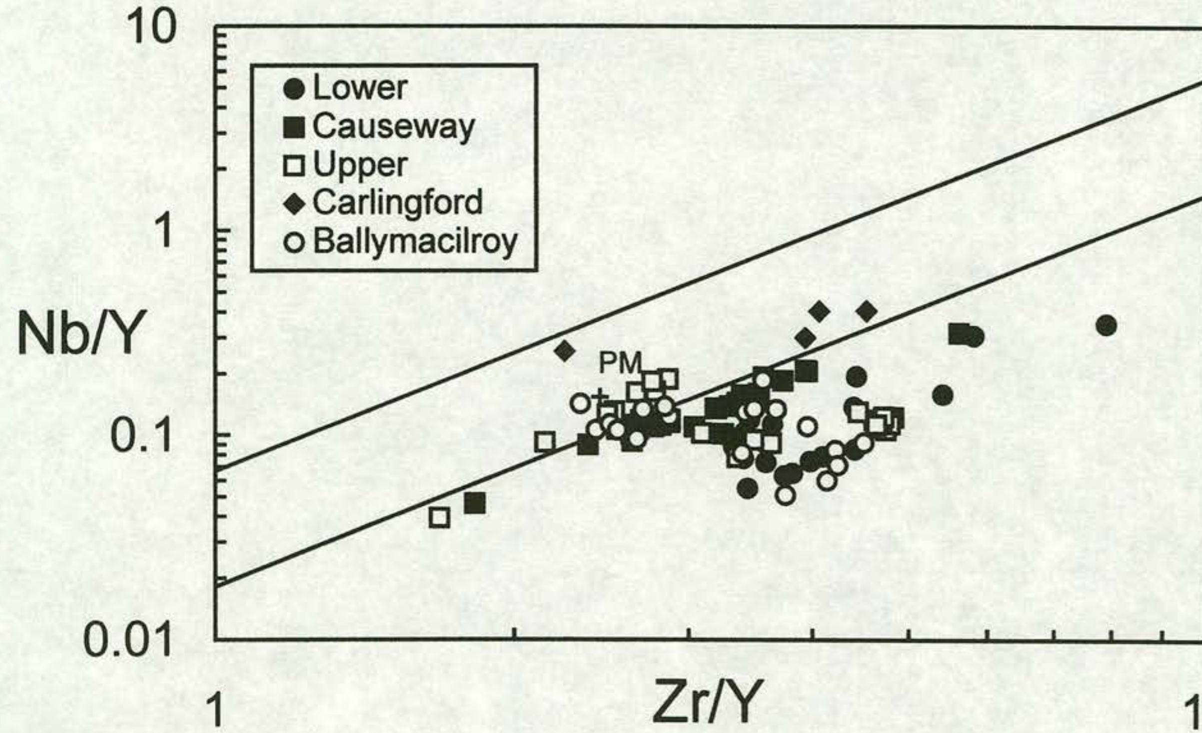


Figure 6.15. Basalt samples from Antrim, divided into the three formations of Wilson and Manning (1978) are plotted on a Zr/Y versus Nb/Y diagram. The Lower and Middle Formation plot below the lower boundary line of the Iceland array. While the Upper Formation also plot within the Iceland array. The Ballymacilroy borehole samples from all three formations plot within the N-MORB array and move into the Iceland array with time.

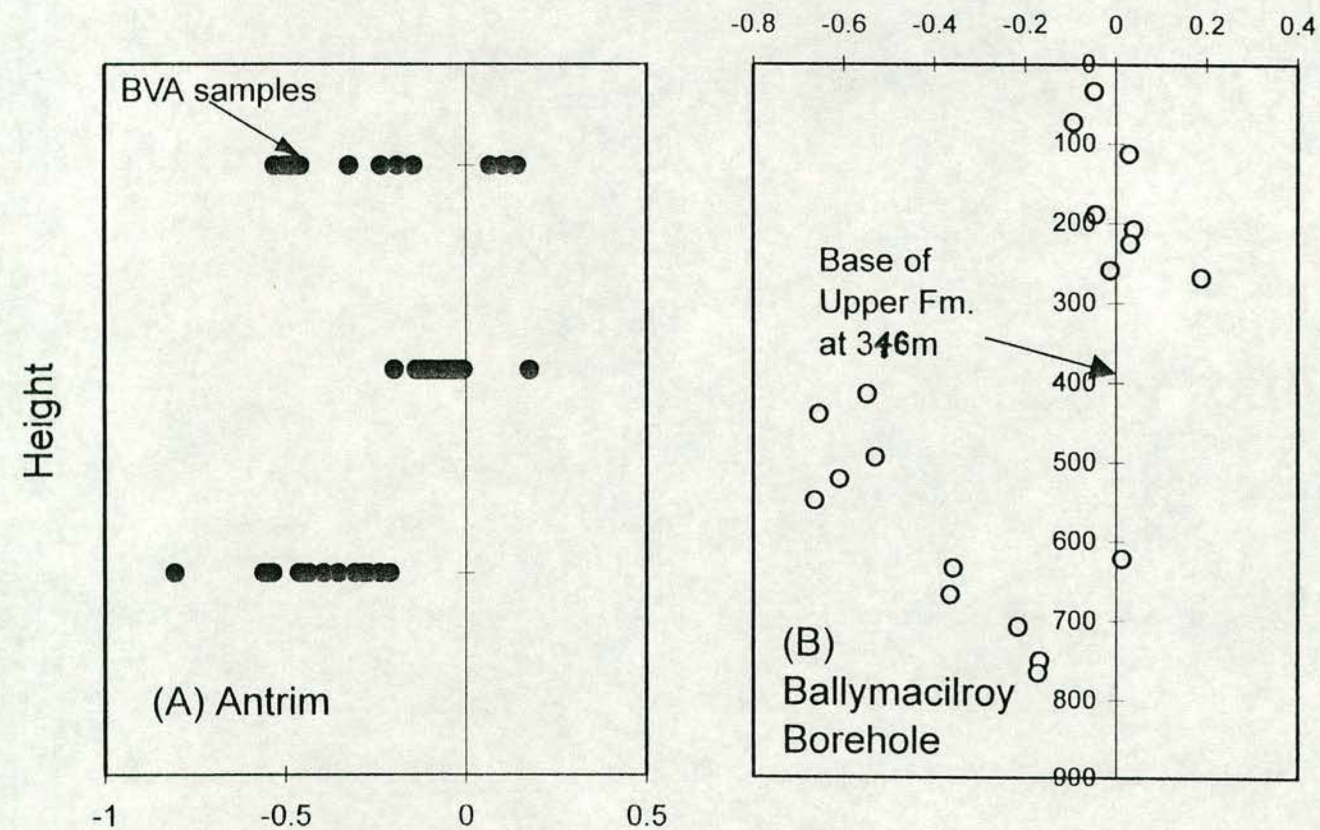


Figure 6.16. (A) Variations in ΔNb and height in the Antrim plateau basalt succession. The samples are divided into Lower, Middle and Upper formations. BVA samples (Wallace, 1995) shown as Upper basalts have been dated as part of this study, and are now considered to be Lower basalts (Chapter 4). There is an decrease in the negative values of ΔNb from the Lower to the Middle Formation. (B) Variations in ΔNb with depth within the Ballymacilroy borehole. Lower basalts have negative ΔNb while the upper basalts have both negative and positive ΔNb. The Interbasaltic Fm. Occurs at a depth of 340m and is 6m thick.

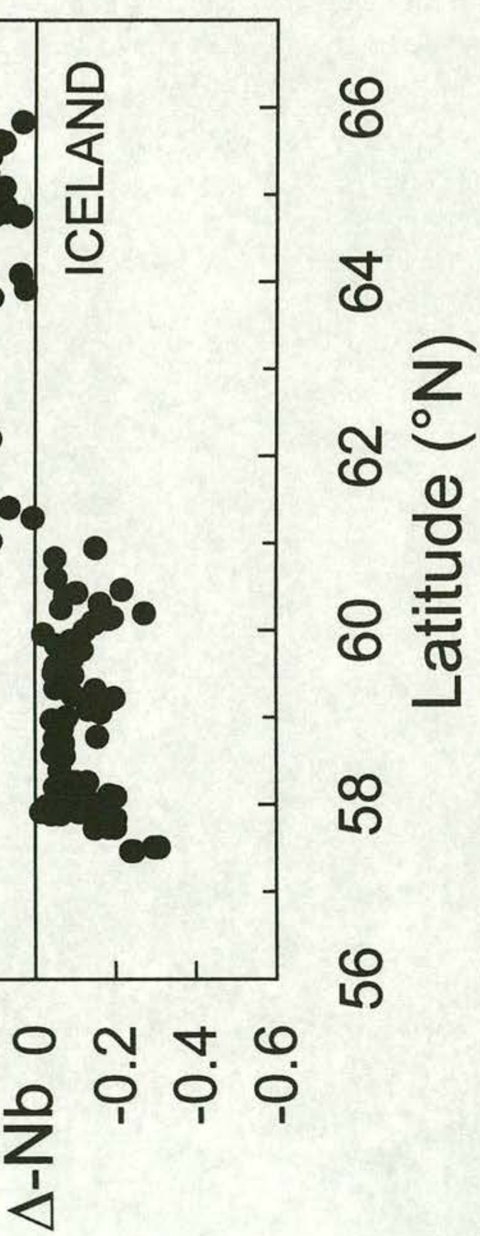


Figure 6.17. Variations in ΔNb down the Reykjanes Ridge, redrawn from Fitton *et al.* (1997). Values of ΔNb can be seen to become less positive going south away from Iceland. The change from positive to negative is sharp not transitional.

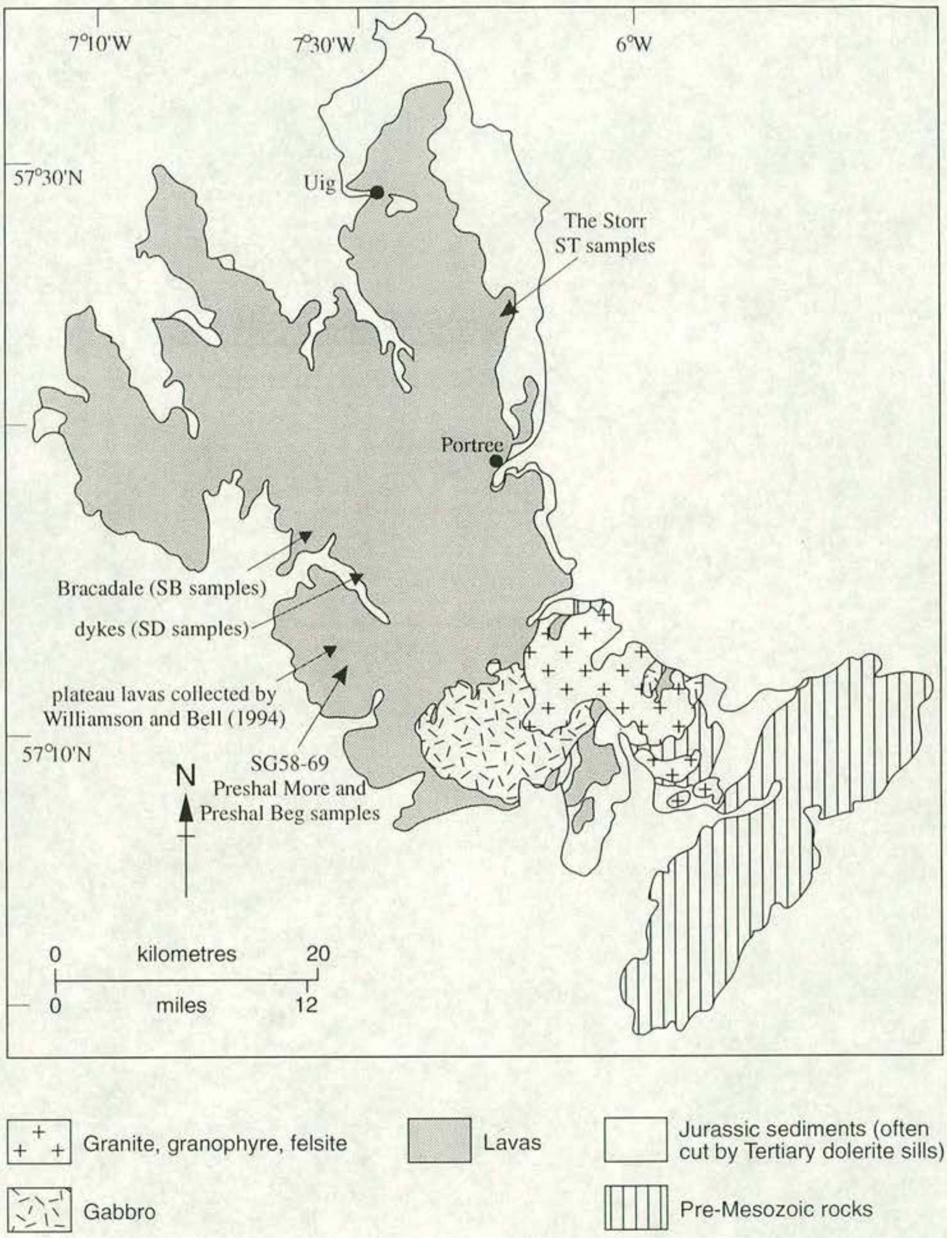


Figure 6.18. Sample localities from Skye shown on a simplified geological map, redrawn from Emeleus and Gyopari (1992).

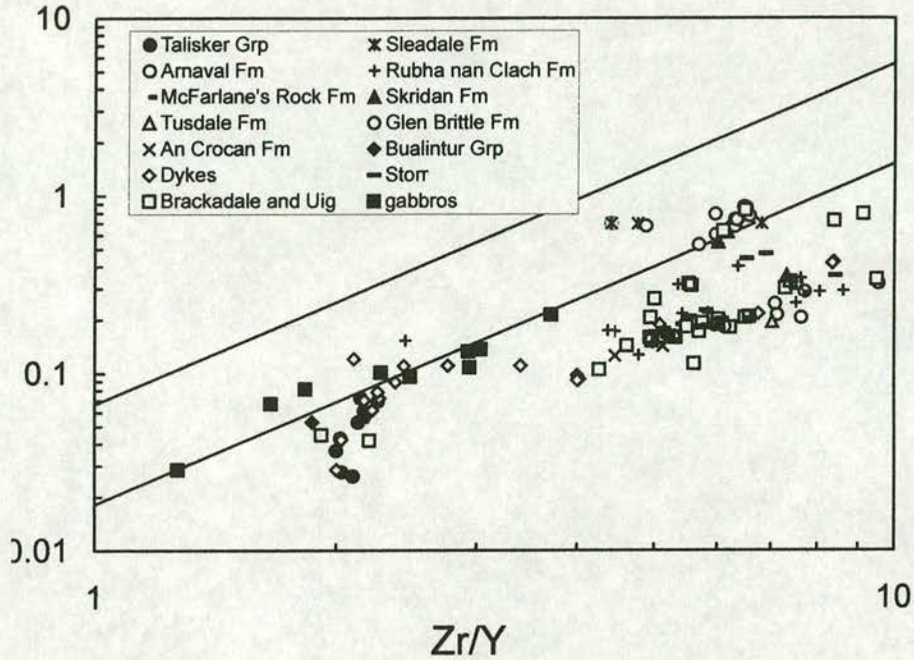


Figure 6.19. Basalts from Skye plotted on a Zr/Y versus Nb/Y diagram showing the boundary lines of the Iceland array (Fitton *et al.,* 1997). Stratigraphic division of the basalt follows the scheme of Williamson and Bell (1994) wherever possible or by location. Dykes were sampled from throughout the magmatic history of Skye and the gabbros are from the Cuillins Centre. Most of the samples from Skye plot within the N-MORB array.

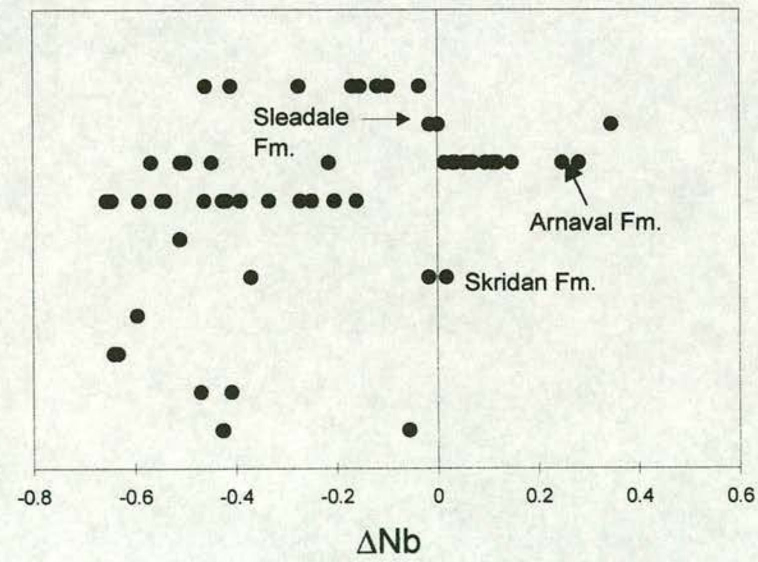


Figure 6.20. Samples divided using the scheme of Williamson and Bell (1994) are plotted on a ΔNb versus relative height diagram. The Bualintur Lava Group (oldest) plot at the bottom, and the Talisker Lava Group (youngest) at the top. A major change from negative to positive values of ΔNb occurs approximately two thirds up the succession. The youngest in the succession, the Talisker Group, have negative ΔNb.

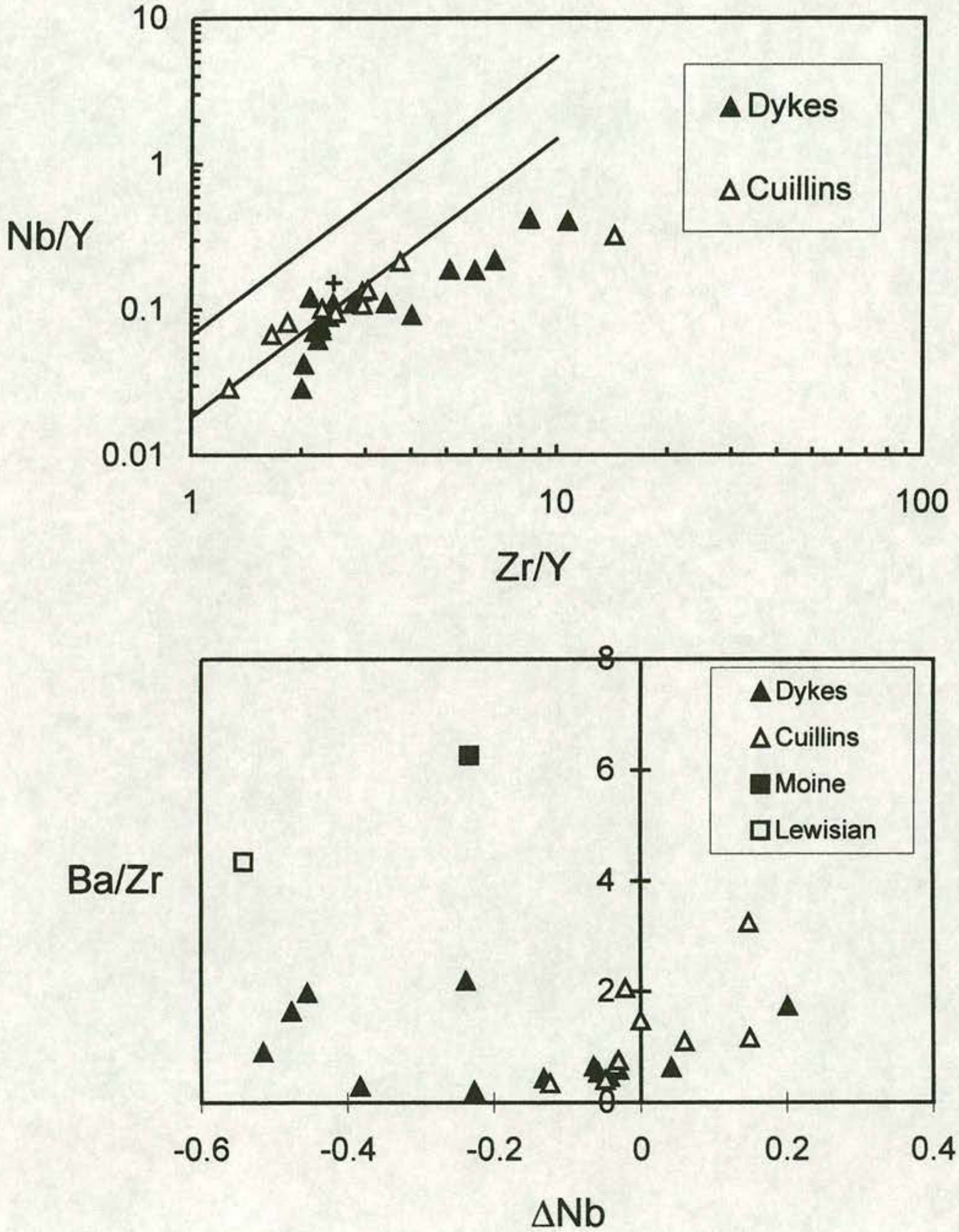


Figure 6.21. The dyke and Cuillin gabbro samples are shown on Zr/Y versus Nb/Y diagram and a plot of Ba/Zr versus ΔNb. They plot within both the Iceland and N-MORB arrays.

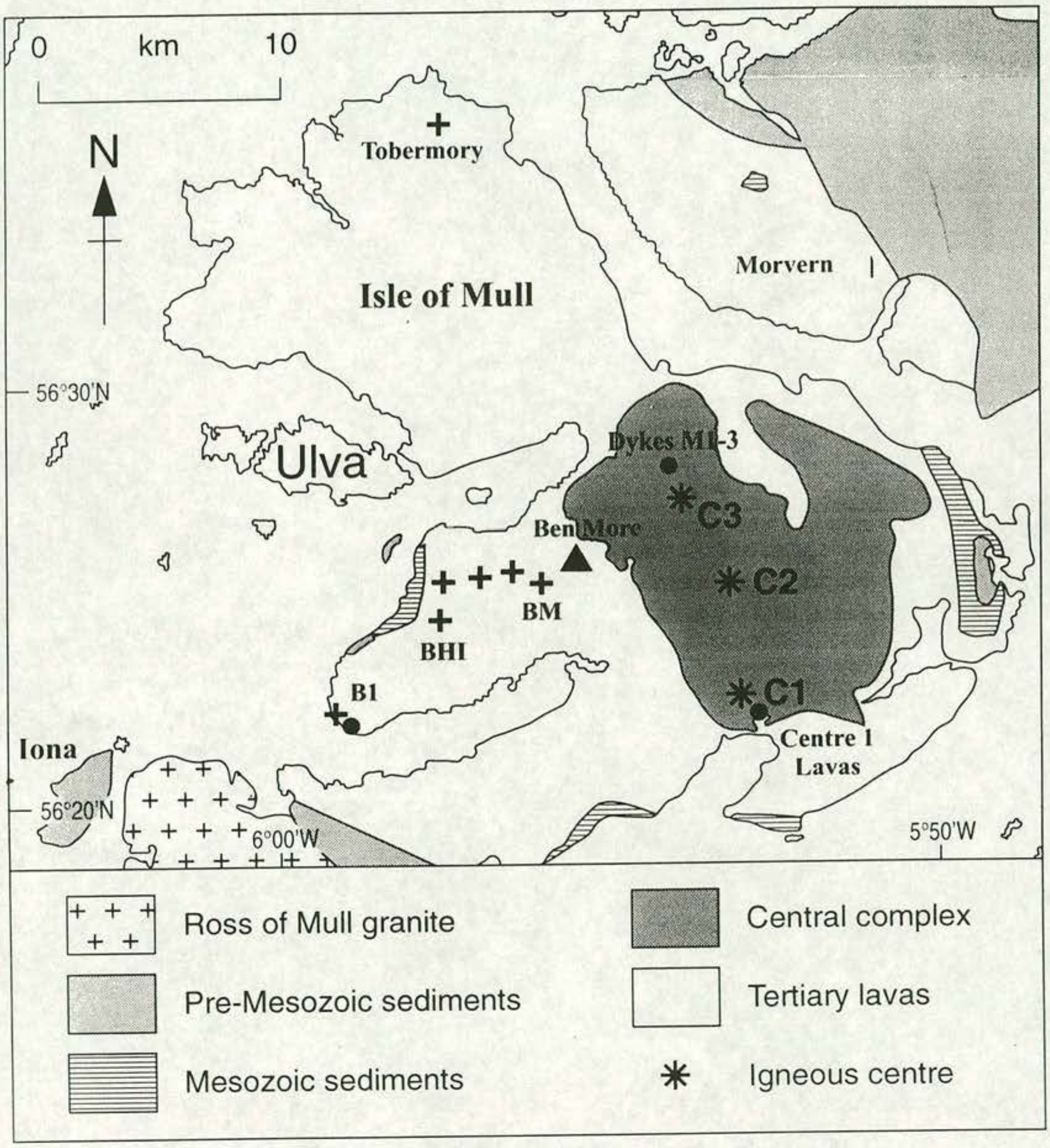


Figure 6.22. A simplified geological map of Mull, after Emeleus and Gyopari (1992) showing the sampled sections of Kerr (1993) and other localities sampled by the author.

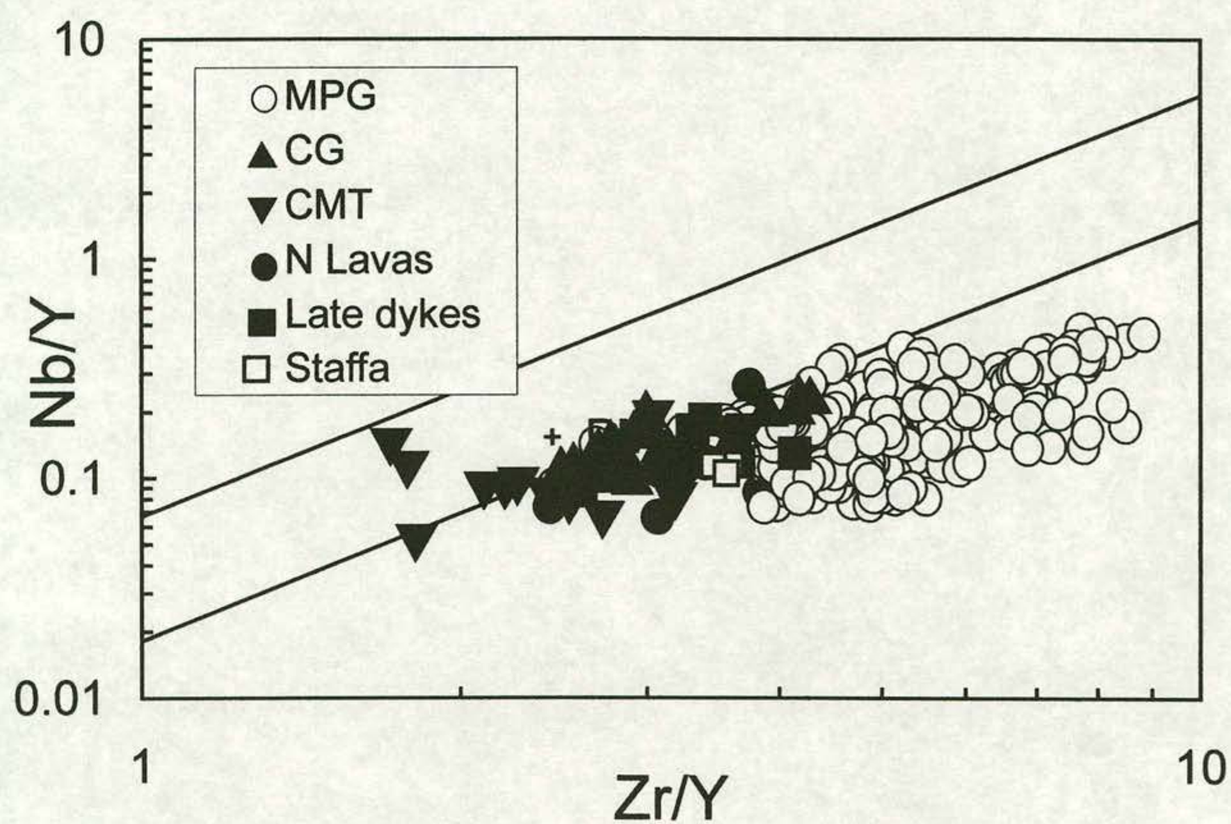


Figure 6.23. Mull and Staffa basalt samples plotted on the Zr/Y versus Nb/Y discrimination diagram of Fitton *et al.* (1997). PM = Primitive mantle; MPG = Mull Plateau Group; CG = Coire Gorm magma type; CMT = Central Mull Tholeiites; N lavas = Lavas from C1 with normal magnetic polarity; late dykes = dykes that cut the Loch Ba ring dyke. The Mull and Staffa samples define an array from low Zr/Y and positive ΔNb, to high Zr/Y and negative ΔNb.

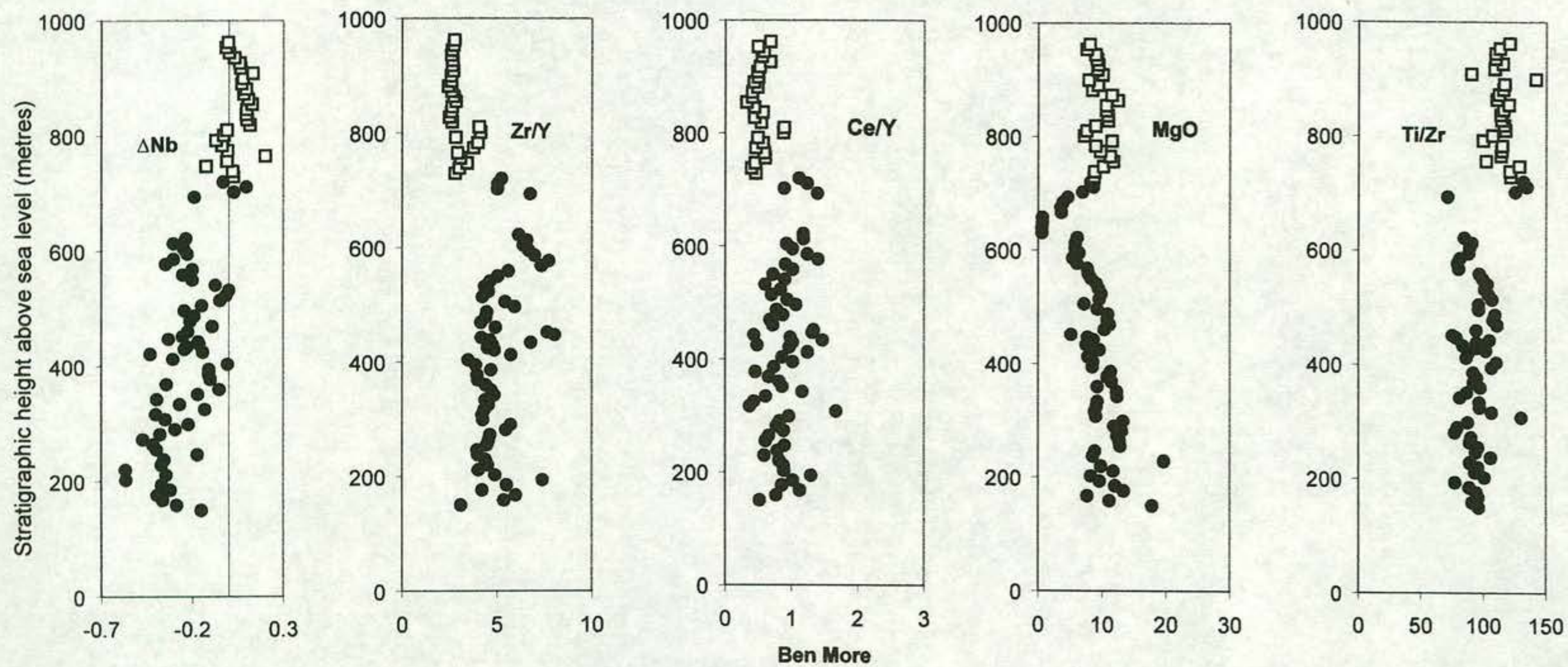


Figure 6.24. Variations in ΔNb, Zr/Y, Ce/Y, MgO, Ti/Zr with height for the Ben More and Beinn na h-Iolaire sections of Kerr (1995), redrawn from Chambers and Fitton (2000). Samples with less than 4 wt % MgO have been eliminated from the other plots. A change in ΔNb from negative to positive occurs at ~700 m, and alternate for another 9 lava flows until 800 m. Towards the top of the section, ΔNb again goes back to being negative. The transition from negative to positive appears to correlate with the subdivision of the basalts into MPG and CG by Kerr (1993) using Ti/Zr. The change from negative to positive ΔNb cannot be caused by the addition of crust, as crust also has negative ΔNb.

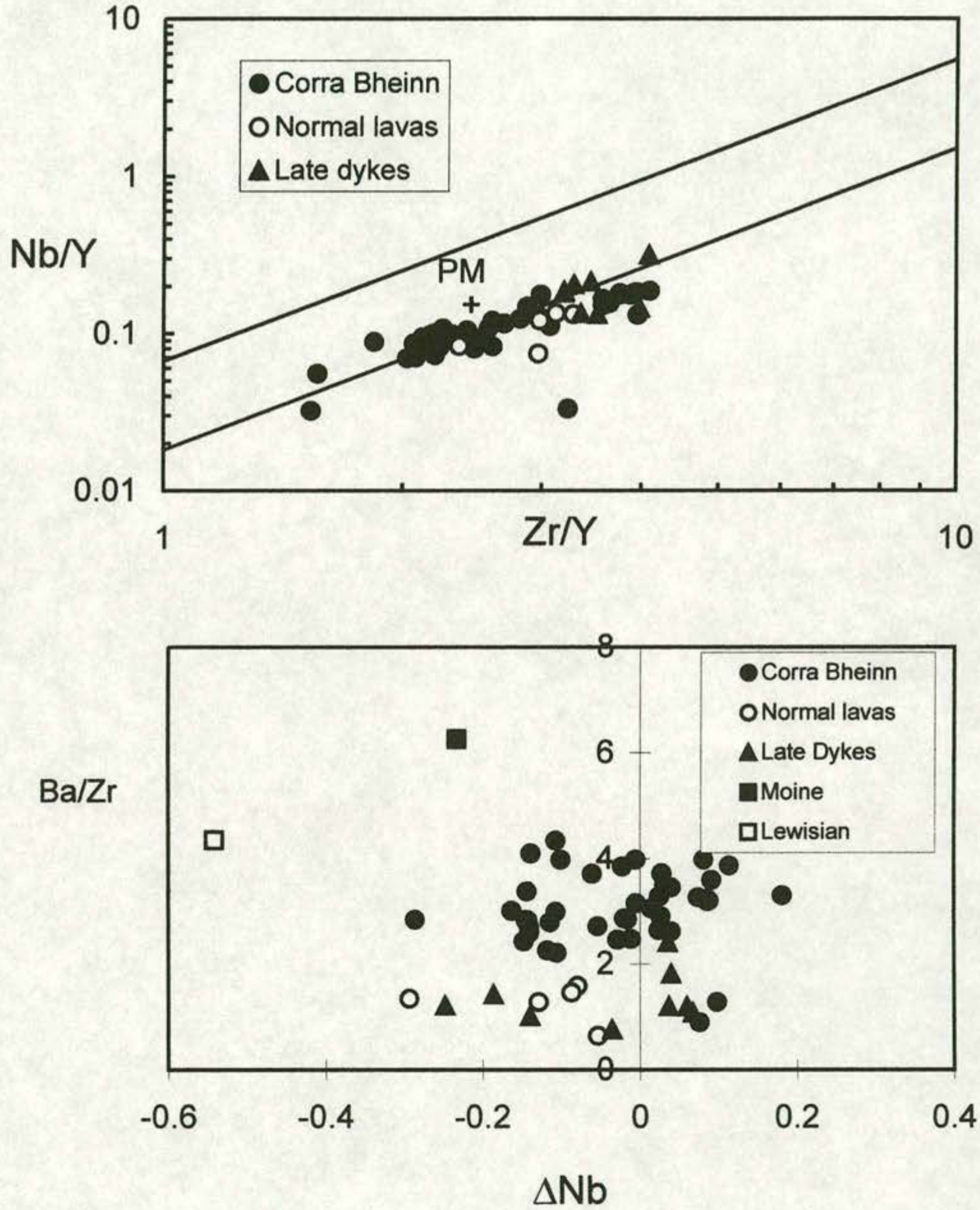


Figure 6.25. Samples from the Corra Bheinn layered gabbro (Chambers, 1996), the lavas with normal magnetic polarity and the late dykes are shown on a plot of Zr/Y versus Nb/Y and Ba/Zr versus ΔNb. The normal polarity lavas, occurring in C1, have negative ΔNb whereas the layered gabbro from (Centre 2) and the late dykes plot within both the N-MORB and Iceland arrays. The gabbro can be seen to have higher Ba/Zr ratios than the other samples, reflecting plagioclase accumulation. Average values of Moine pelite (filled square) and Lewisian granulite (open square) are also shown (Thompson *et al.*, 1986; Weaver and Tarney, 1981).

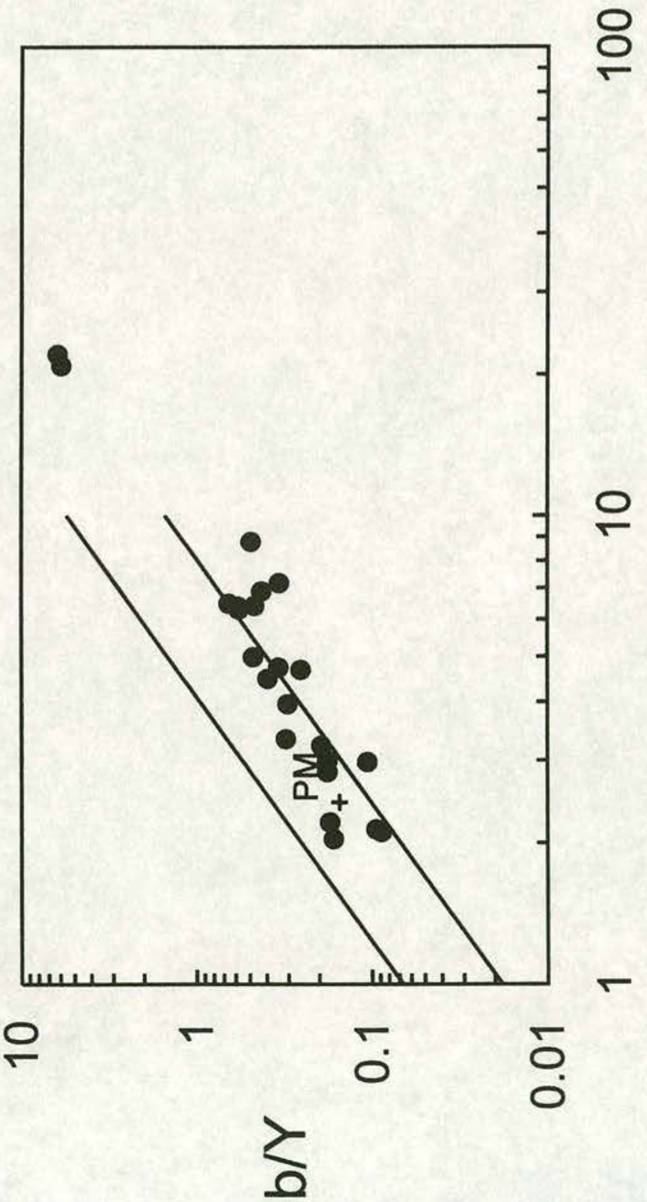


Figure 6.26. Offshore samples plotted on a Zr/Y versus Nb/Y diagram. More than half of the samples plot within the boundary lines of the Iceland array. Two Rosemary Bank samples have high Zr/Y (~11), and as the Iceland array is based on analyses of basalts the array does not extend that far.

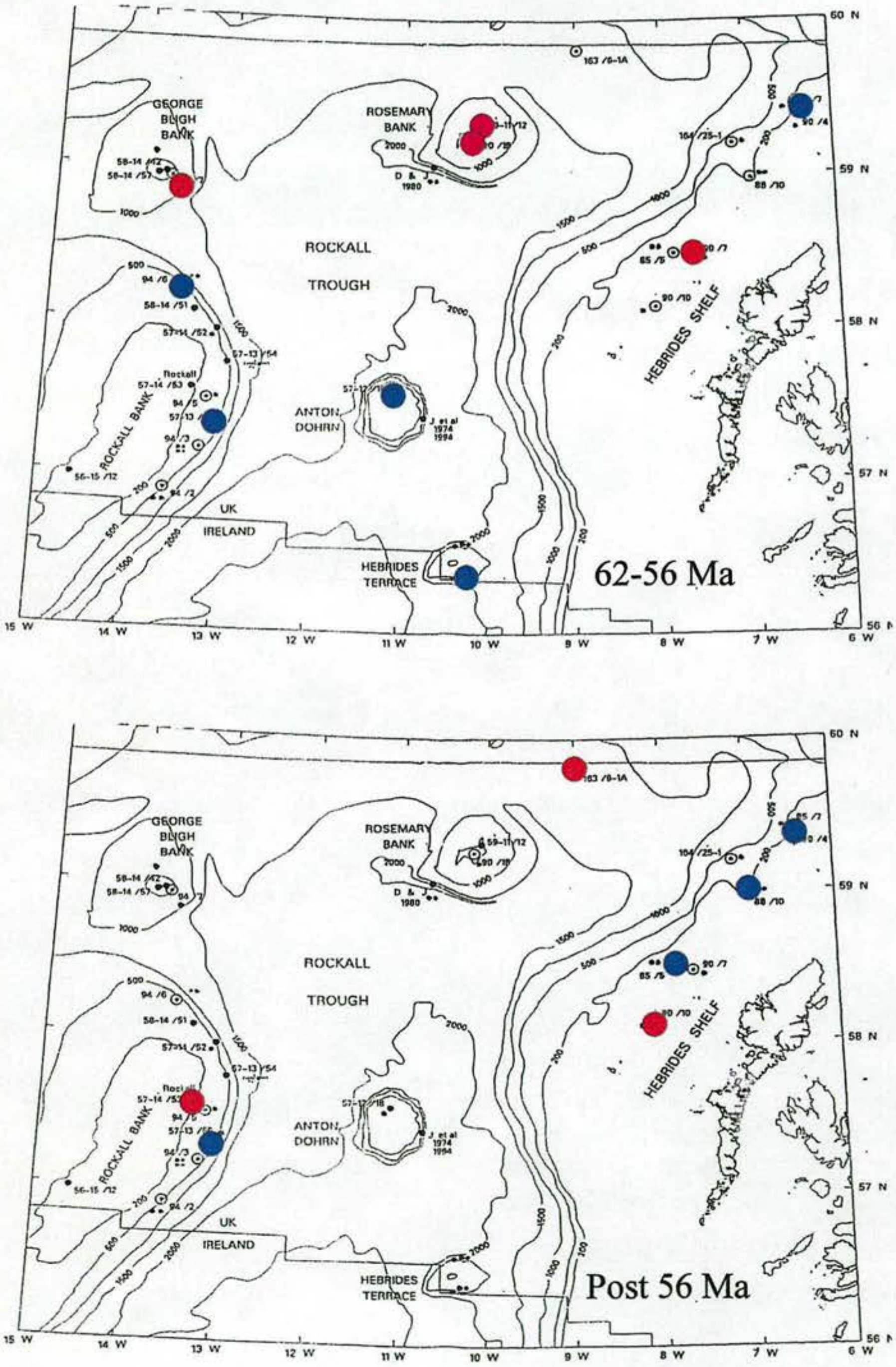


Figure 6.27. The offshore samples from West of Shetland divided into the 2 phases of Saunders *et al.* (1997). Both 'Icelandic' (blue circles) and N-MORB-like basalts (red circles) occur throughout the magmatic history of this area. Two Rosemary bank samples are shown as pink circles as they have Zr/Y higher than the Iceland array.

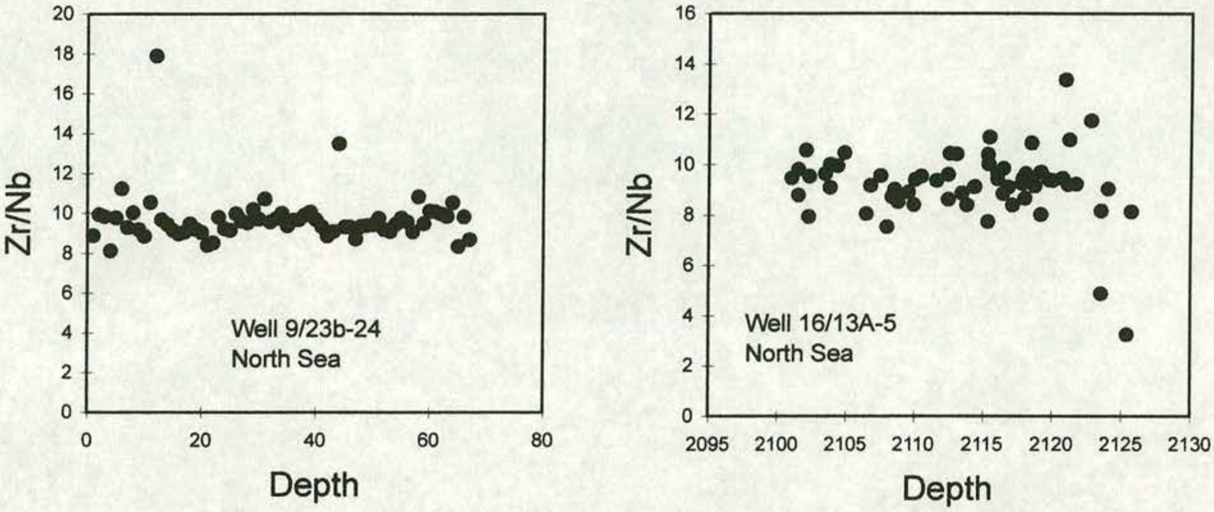


Figure 6.28. Variation in Zr/Nb with depth in tuffs from the North Sea. The tuffs have almost constant Zr/Nb ratio of 10.

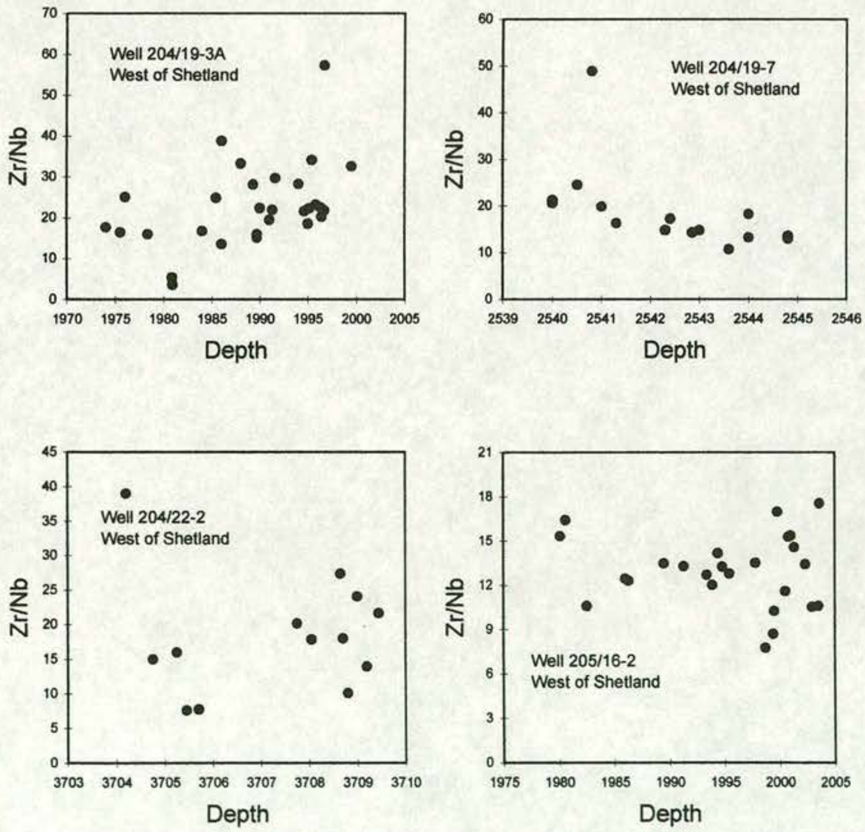


Figure 6.29. Variation in Zr/Nb with depth in tuffs from West of Shetland. In general, the Zr/Nb ratio is higher than that for the North Sea tuffs.

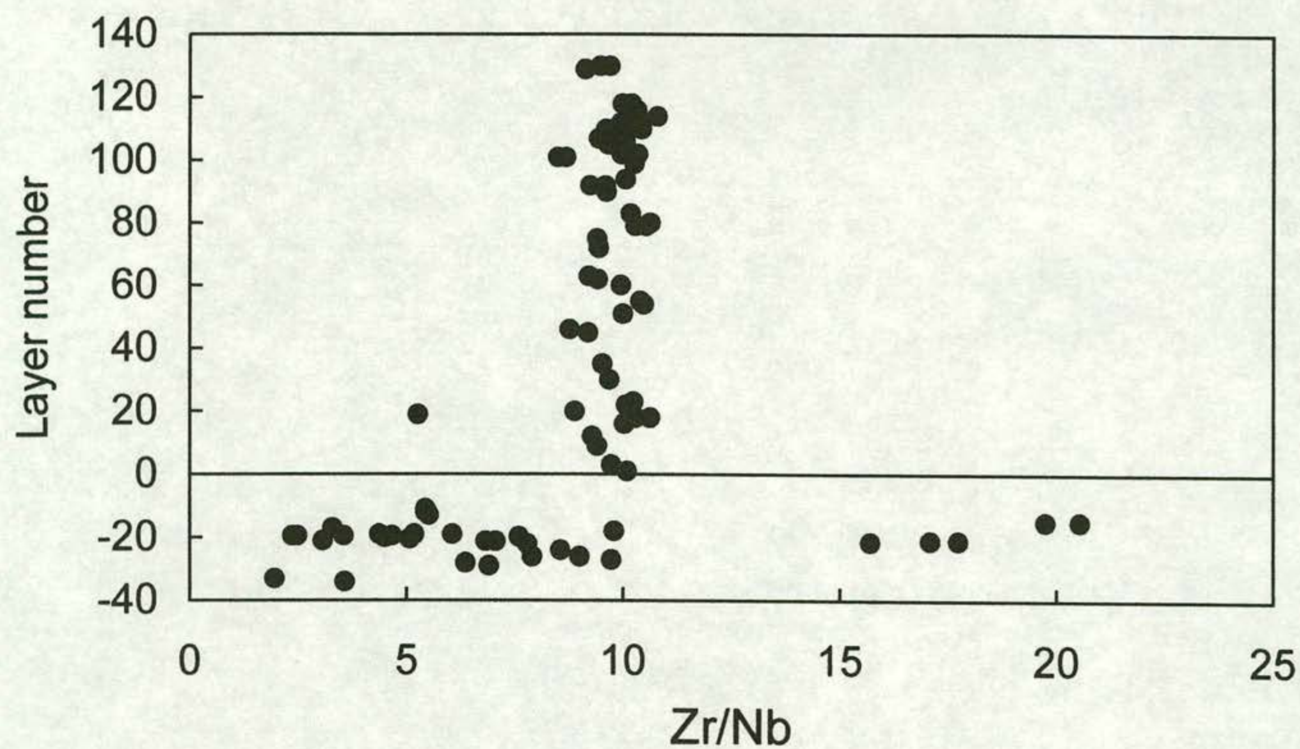
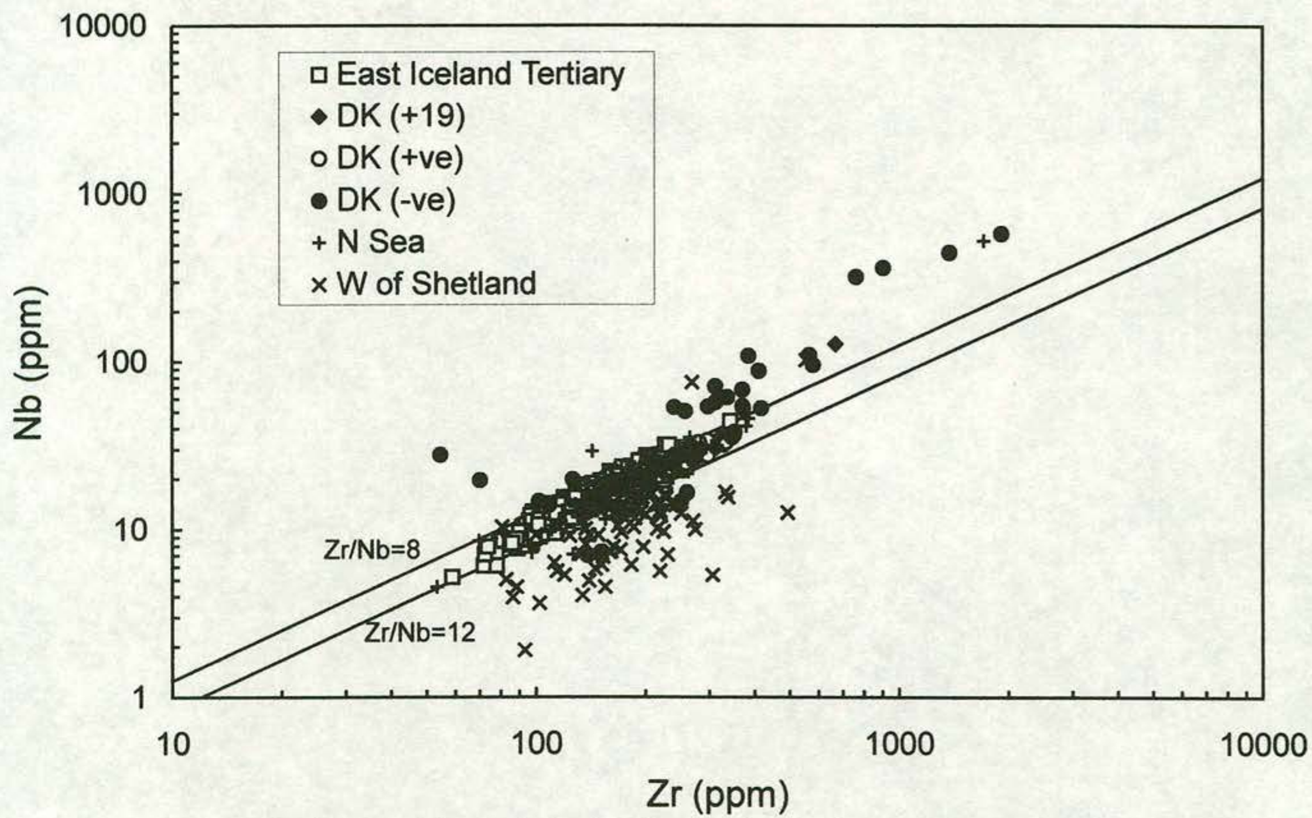


Figure 6.30. Variation in Zr/Nb and layer number in tuffs from the Danish Fur Formation. Tuff layers have been divided into a negative and positive series (Bøggild, 1918). The positive series have an almost constant Zr/Nb ratio of 10, while the negative series show much larger range in Zr/Nb.



of Shetland tuffs and the East Iceland Tertiary basalts (G. Fitton, unpublished data). West of Shetland tuffs have much higher Zr/Nb implying a more depleted source than the Iceland Tertiary and the Danish ashes.

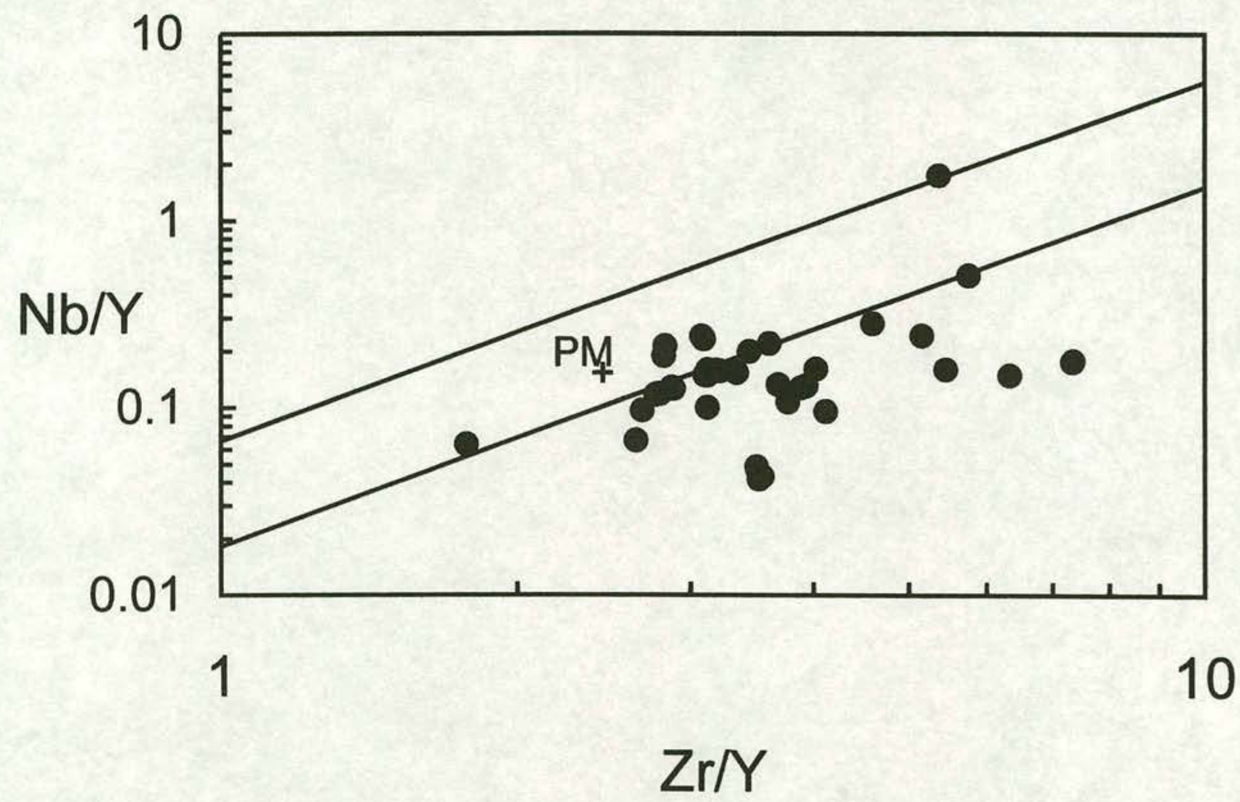


Figure 6.32. Anglesey dyke samples plotted on a Zr/Y versus Nb/Y diagram. The dykes form an array crossing the lower boundary line of the Iceland field.

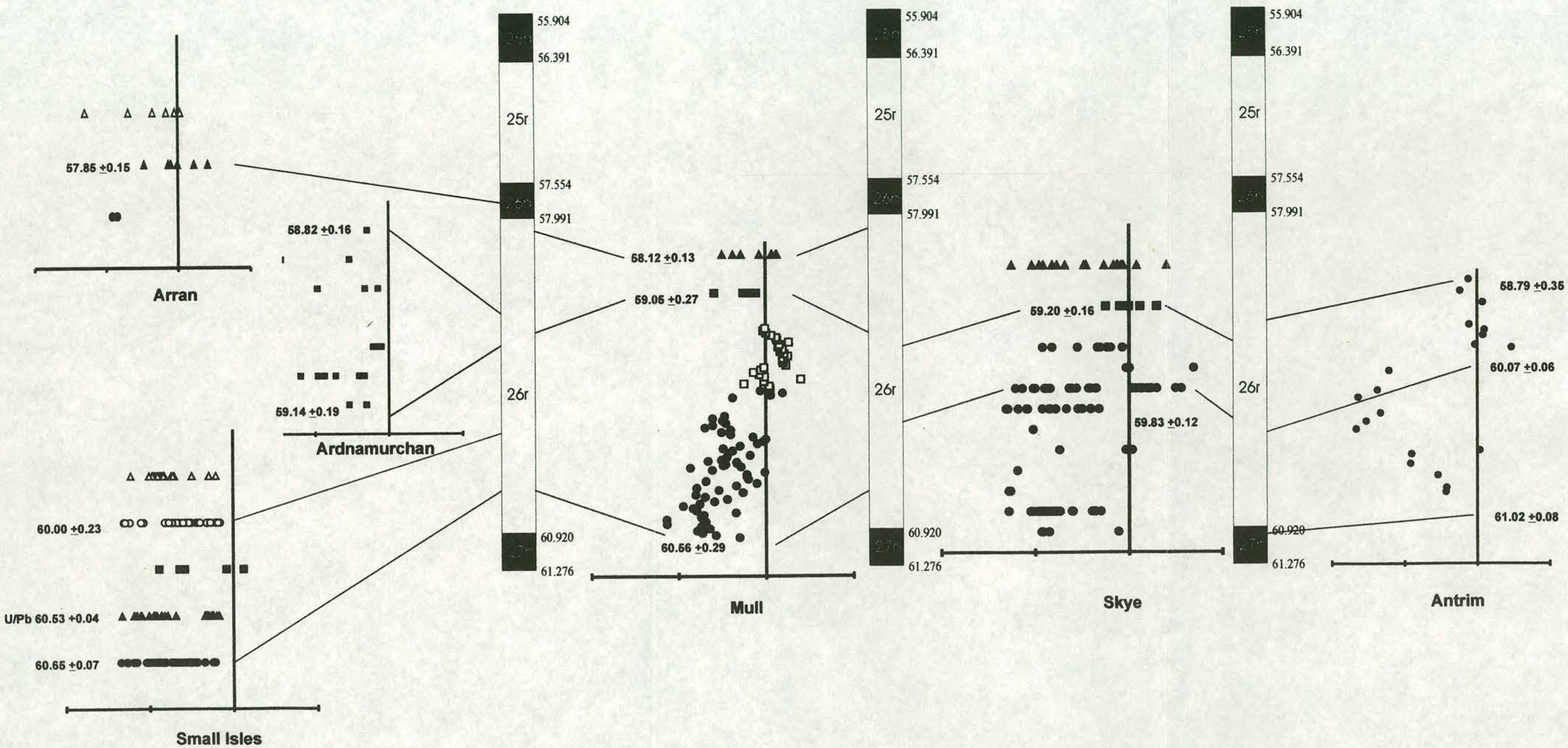


Figure 6.33. Stratigraphic variations in ΔNb correlated to the geomagnetic timescale of Berggren *et al.* (1995). Black indicates normal polarity events. All of the ages used are from this study or U/Pb ages from Hamilton *et al.* (1998). Symbols used are as follows: Circles = main lava series for each area; open squares = Coire Gorm magma type, Mull; triangles = dykes; closed squares = samples from the central complex. The geochemical plots have ΔNb as the X axis from 0.5 to –1, and relative stratigraphic height on the Y axis. Initial magmatism is dominated by an N-MORB mantle source with a change to and Icelandic source within 1 m.y.

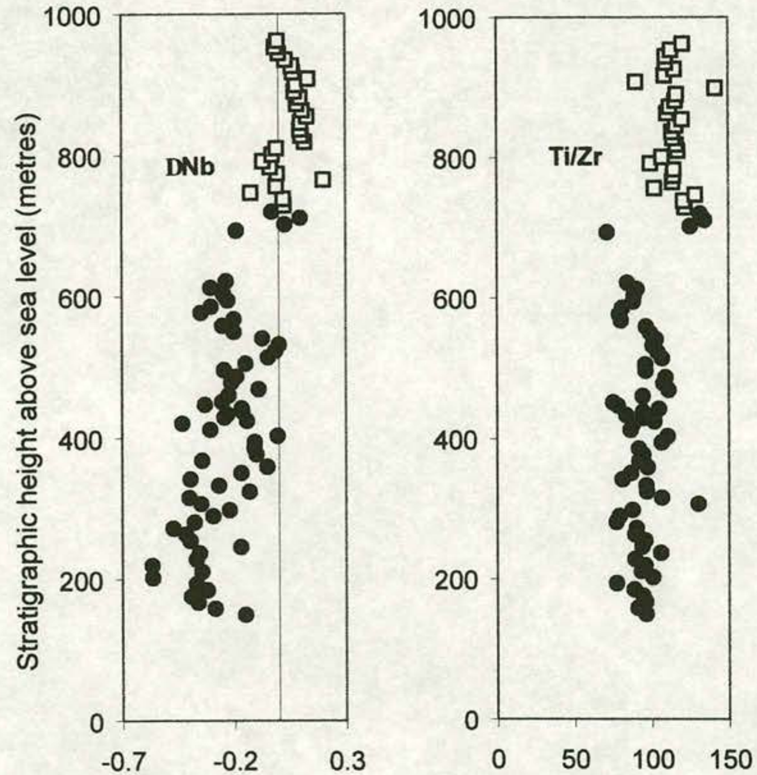


Figure 6.34. Variation in ΔNb and Ti/Zr through the Mull plateau lava succession. Ti/Zr ratios are used by Kerr (1995) to divide the Mull Plateau Group (circles) from the Coire Gorm magma type (squares). A good correlation between Ti/Zr and ΔNb is seen in Mull.

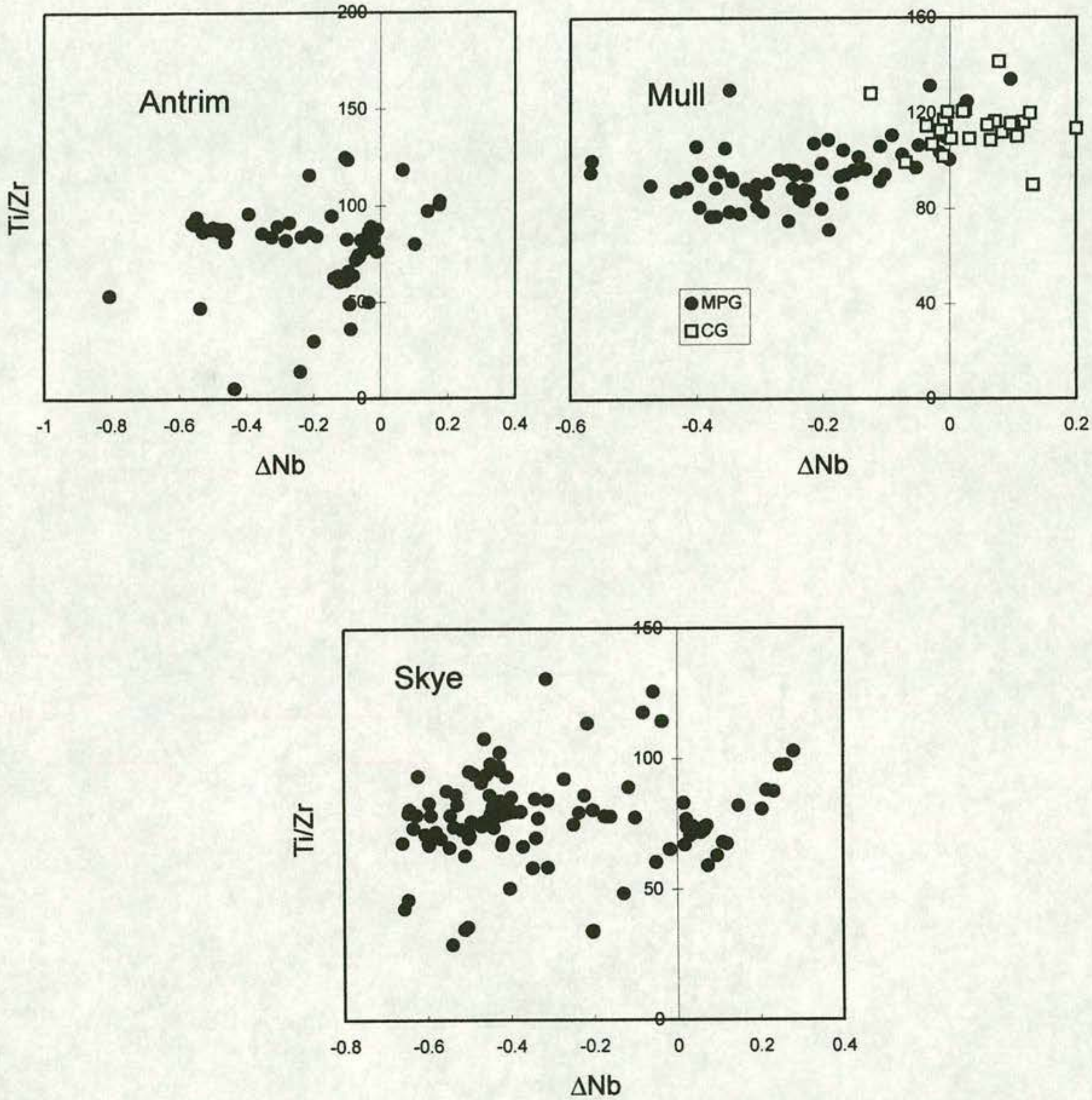


Figure 6.35. Variation in Ti/Zr with ΔNb in the Mull, Skye and Antrim lava successions. No correlation exists between high Ti/Zr and positive values of ΔNb, apart from in Mull.

Igneous Centre	Sample	ΔNb	Age (Ma)	Error (Ma)	Polarity
Mull					
	Base lavas	negative	60.50	0.29	R
	middle lavas	positive	58.38 or TFA 59.5	0.19	R
	top lavas	negative			R
	C1 lavas	negative	59.05	0.27	N
	C2 gabbro	both			N
	Loch Ba Ring dyke	n/a	58.48	0.18	N
	Dykes	both	58.12	0.13	R
Small Isles					
	Eigg Lava Fm	negative	60.65	0.07	R
	Dykes	negative			R
	Rum Central Complex	negative (1 +ve)	60.01	0.45	R
	Canna Lava Fm	negative	60.00	0.23	R
	Dykes	negative			R
Arran					
	lavas	negative			R
	N Granite	n/a	57.85	0.15	N
	Dykes	both			N
	Dykes	both			R
Skye					
	Middle lavas	both	59.83	0.12	R
	Talisker Group	negative			R
	Cullins Gabbros	both			R
	Dykes	both	59.20	0.16	R/N
Antrim					
	Lower basalts	negative	61.02	0.08	R
	Causeway Tholeiites	negative	60.07	0.06	R
	Upper basalts	both	58.79	0.25	R
Ardnamurchan					
	Lavas	negative	59.14	0.19	R
	C1-3	negative	58.82	0.16	R
Anglesey					
	Dykes	both			R/N
	3317	positive	60.05	2.85	?
W of Shetland					
	lavas	both	?		R/N

Table 6.1. Summary table of changes in ΔNb, $^{40}Ar/^{39}Ar$ geochronology and magnetic stratigraphy in the BTIP.

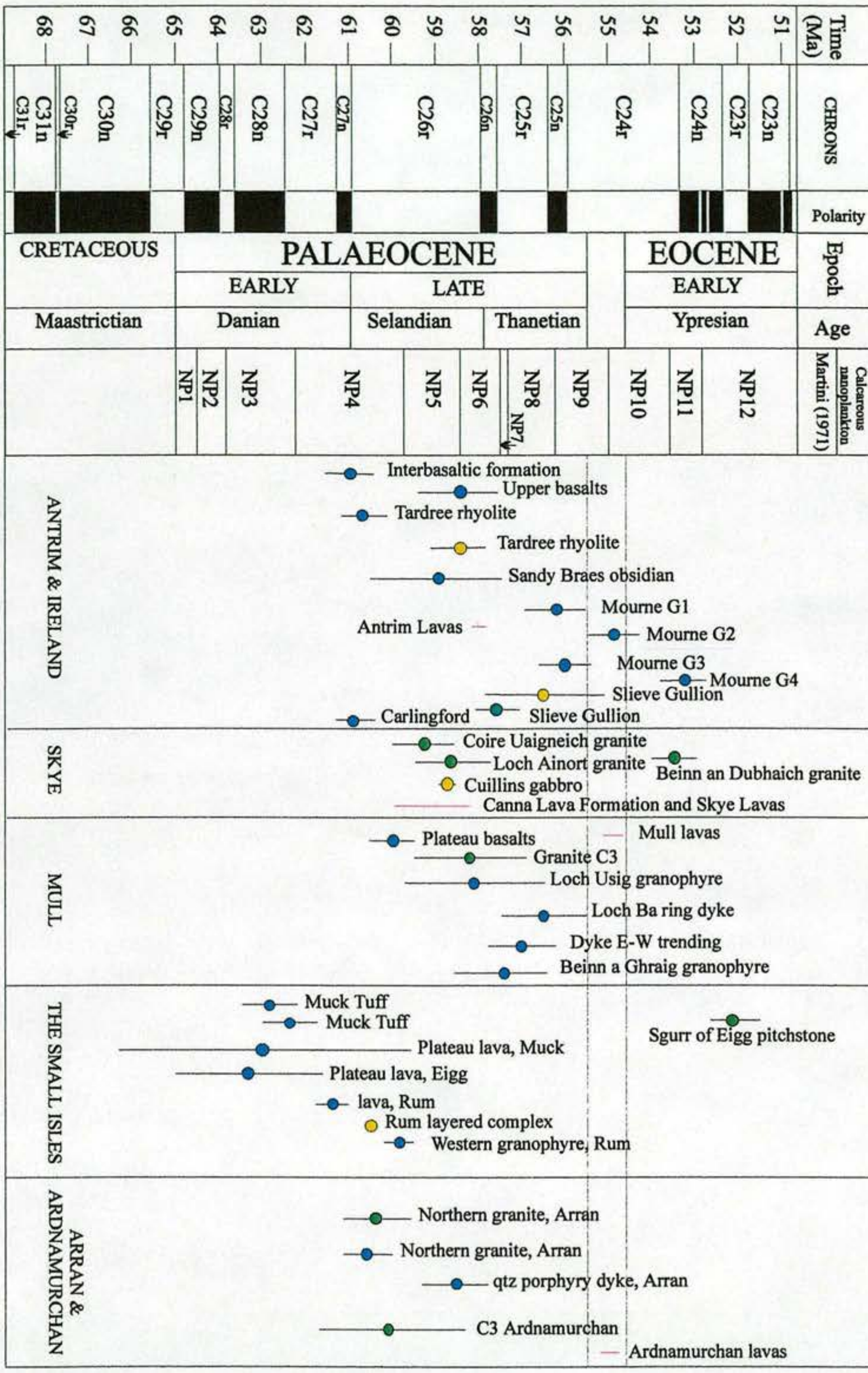


Figure 7.1. Existing radiometric ages for the BTIP, available prior to this study, are correlated to the geomagnetic time scale of Berggren *et al.* (1995). Igneous activity in the BTIP occurs over a 10 m.y. period, with the bulk of activity occurring at 58 Ma. Palynological ages for the BTIP are from Bell and Jolley (1997) and Jolley (1997) are shown as red lines, U/Pb ages in yellow, Rb-Sr ages in green, and $^{40}Ar/^{39}Ar$ ages in light blue.

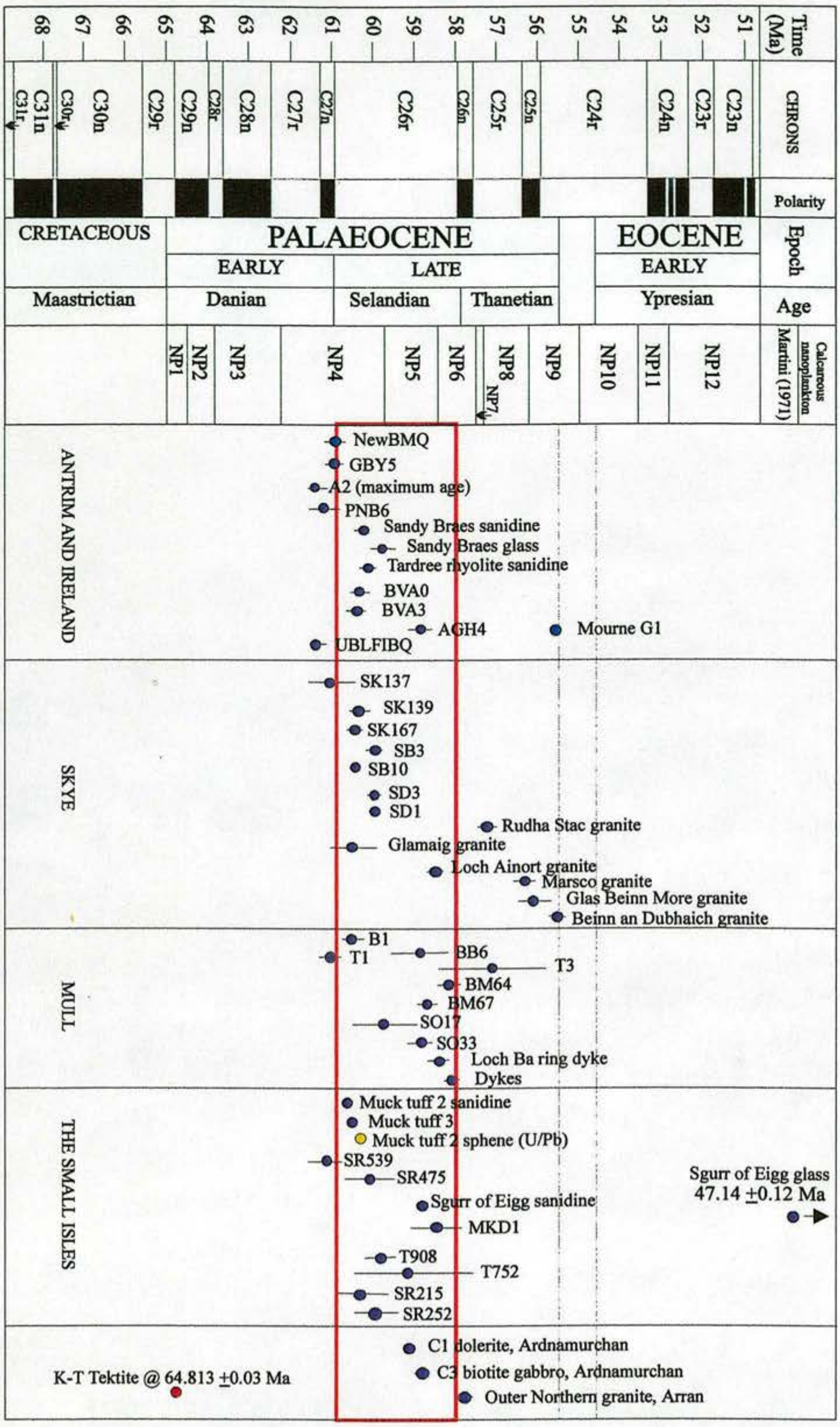


Figure 7.2. The new $^{40}Ar/^{39}Ar$ ages for the BTIP presented in this thesis are correlated to the geomagnetic time scale of Berggren *et al.* (1995). Igneous activity is now confined to a 3 m.y. period beginning at 61 Ma (red box), apart from some late stage granites in Skye and Antrim. The K-T tektite age (red) is also shown as it allows direct correlation to the time scale. A U/Pb sphene age (yellow) from Muck tuff 2 is also plotted.

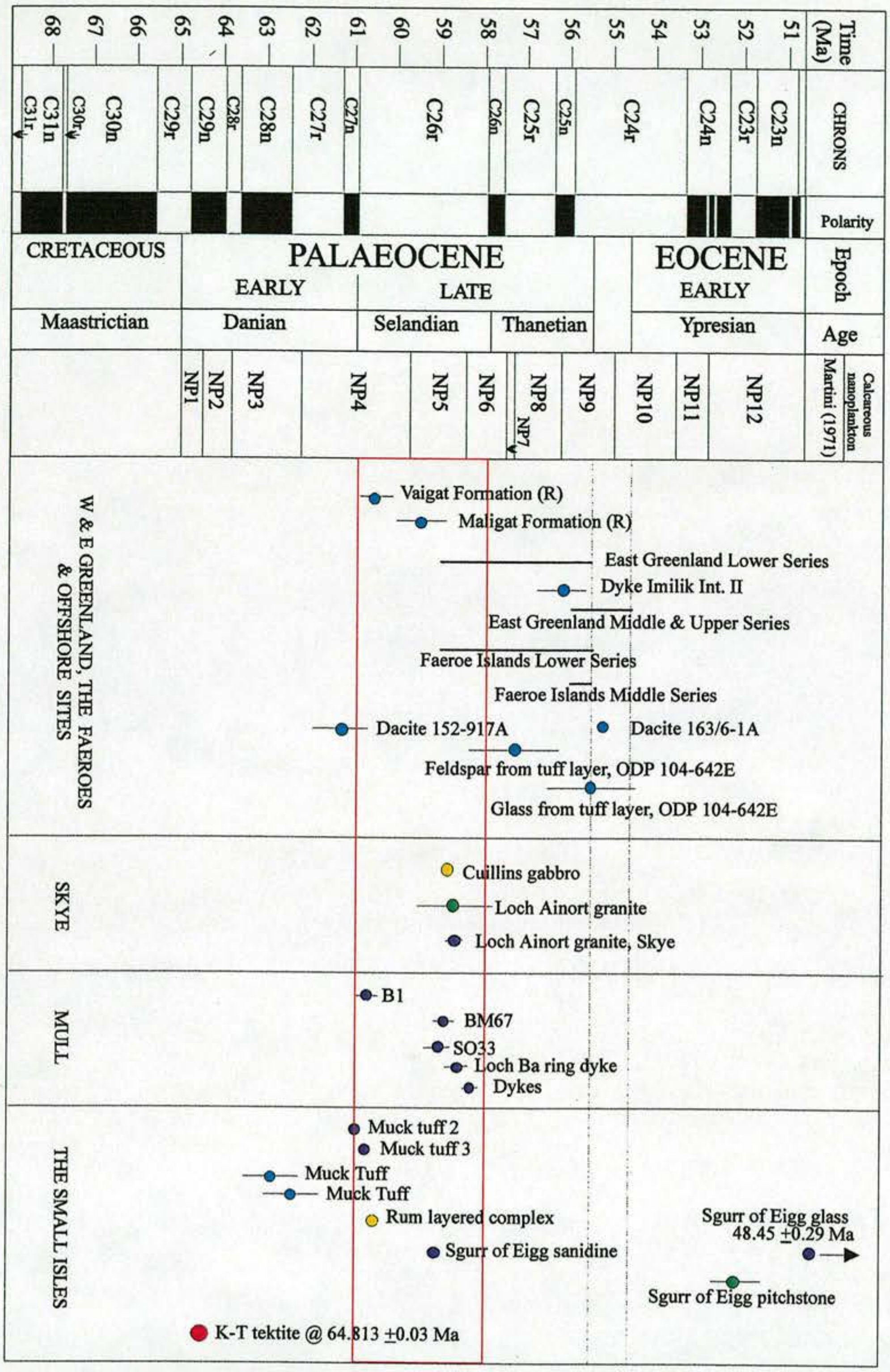


Figure 7.3. Radiometric ages for the NAIP (Chapter 2) including some of the new data presented within this thesis (Chapter 4) are correlated to the geomagnetic time scale of Berggren *et al.* (1995). Both the old and new ages for the Muck tuffs and the Sgurr of Eigg pitchstone are plotted (Pearson *et al.*, 1996; Chambers and Pringle, submitted a; Dickin and Jones, 1983). $^{40}Ar/^{39}Ar$ ages from this study = dark blue; $^{40}Ar/^{39}Ar$ ages prior to this study = light blue; tektite = red, Rb-Sr age = green, and U/Pb age = yellow.

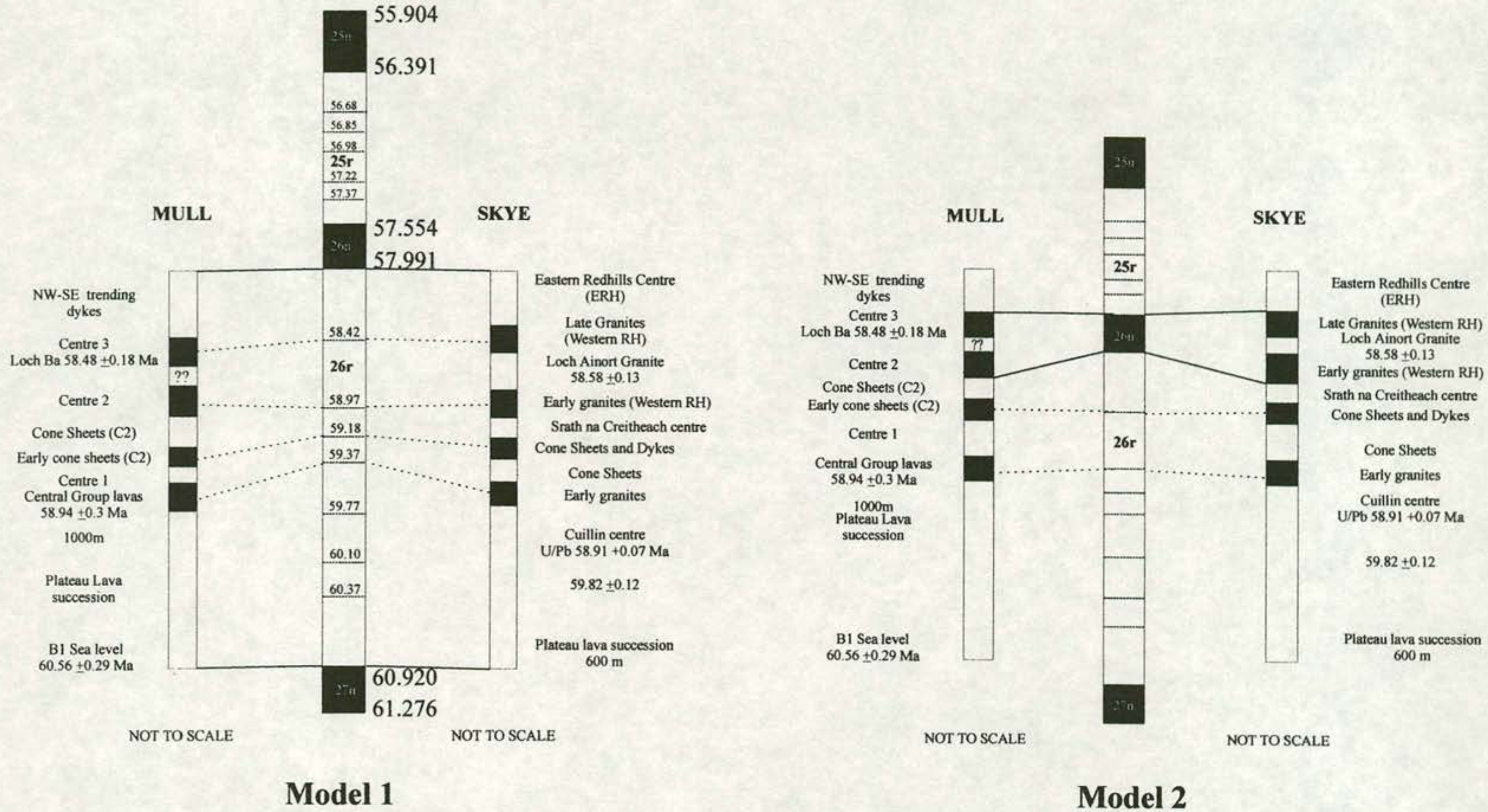


Figure 7.4. Two models that seek to account for the presence of normal polarity events within Chron 26r. Model 1 shows the normal polarity events (black) correlated to cryptochrons within Chron 26r. Model 2 correlates the igneous activity in Centres 1 and 2 in Mull and the Redhills in Skye to Chron 26n in an older position. The existence of a least two cryptochrons is still required to account for all of the normal polarity events.

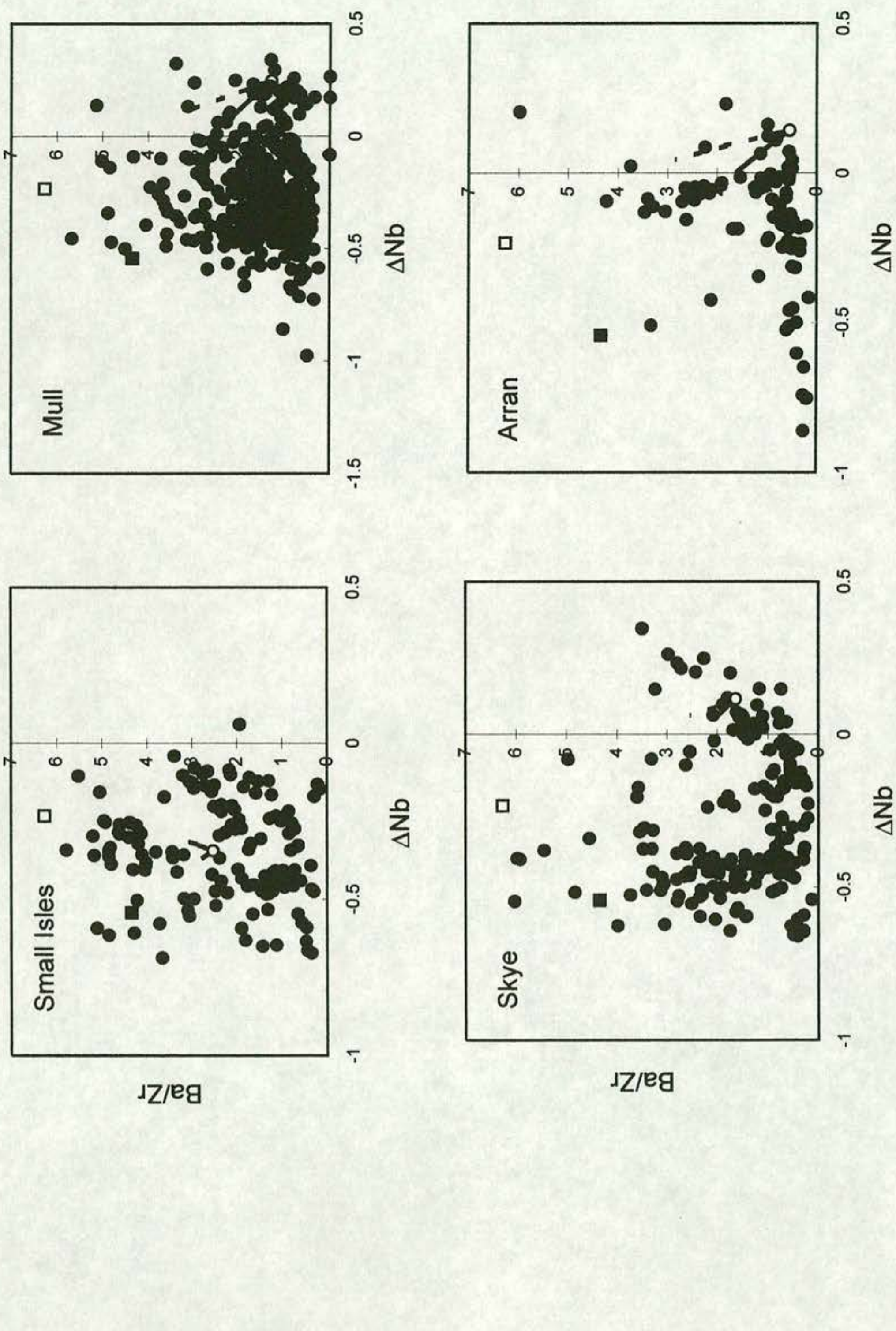


Figure 7.5. Variations in Ba/Zr with ΔNb in Mull, Skye, the Small Isles and Arran. An average basalt (open circle) for each area is plotted with lines representing the addition of 20% crust. Average values of Moine pelite (filled square) and Lewisian granulite (open square) are shown. The addition of up to 20% crust does not change the value of ΔNb significantly.

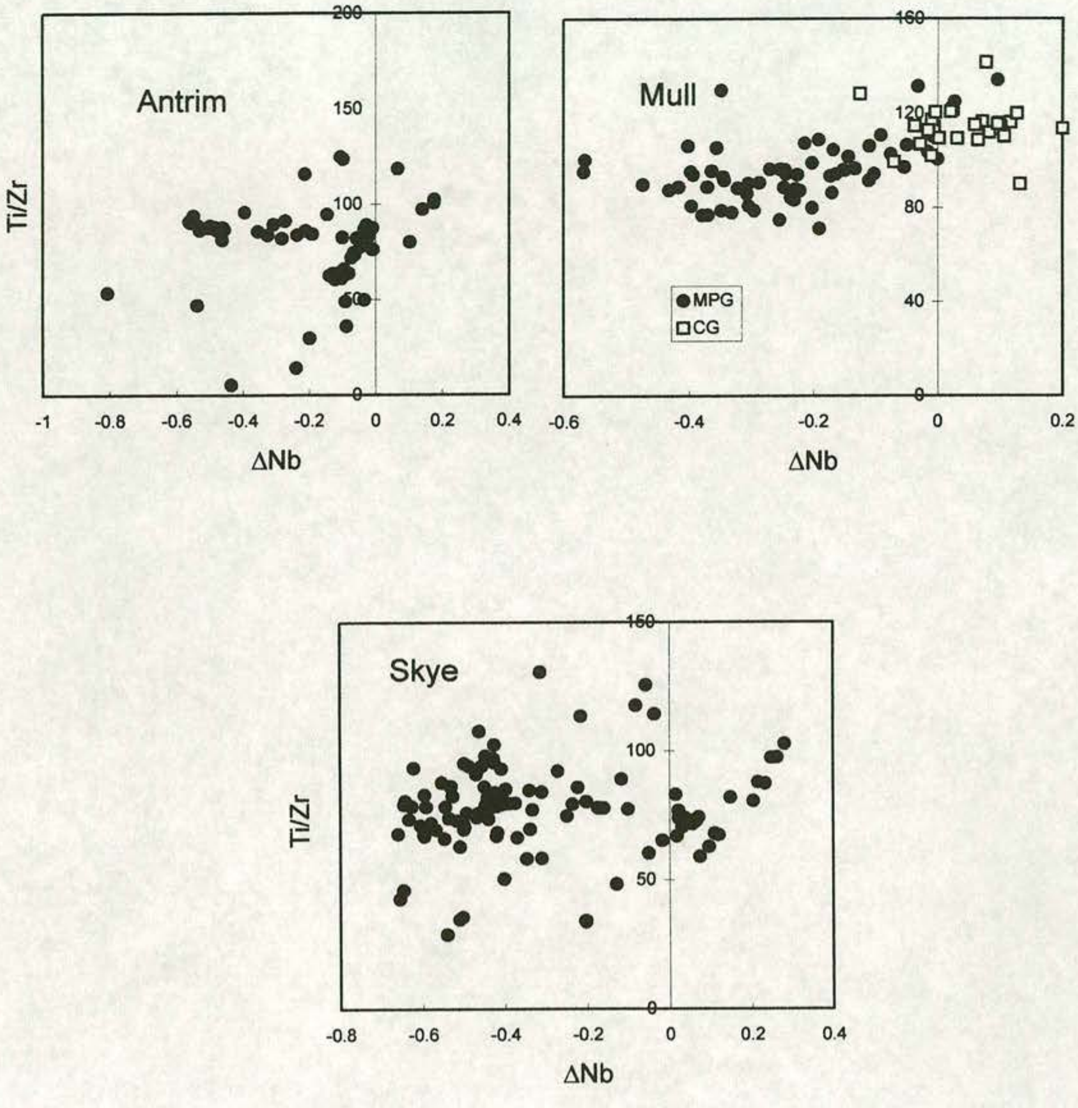


Figure 7.6. Variations in Ti/Zr with ΔNb in the Antrim, Skye and Mull. A correlation between the two can only be seen in Mull.

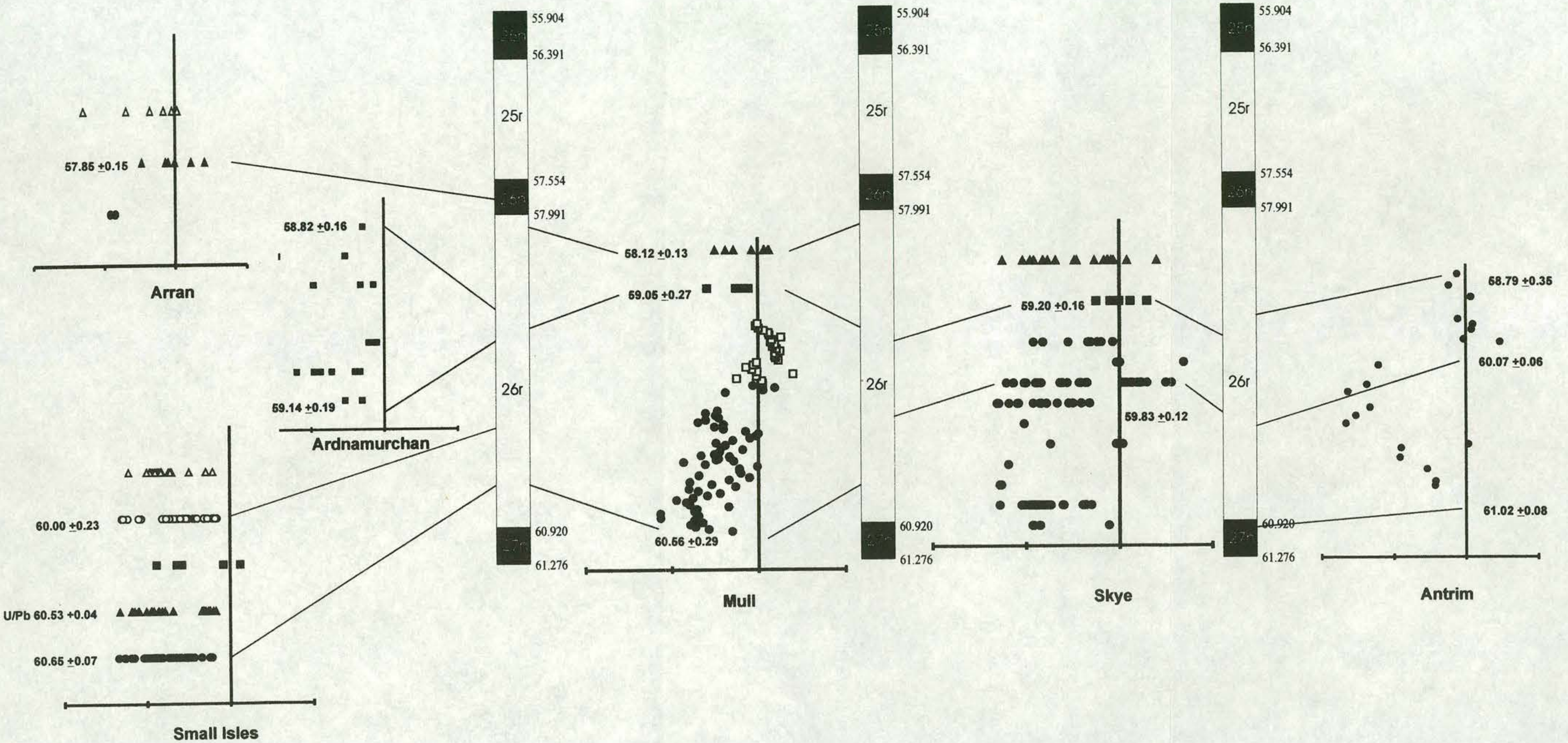


Figure 7.7. Stratigraphic changes in ΔNb are correlated to the geomagnetic time scale of Berggren *et al.* (1995) using the new $^{40}Ar/^{39}Ar$ ages presented in this thesis. Black indicates normal polarity Chrons, other symbols used are as follows: Circles = main lava series for each area; open squares = Coire Gorm magma type, Mull; triangles = dykes; closed squares = samples from the central complex. The geochemical plots have ΔNb as the X axis from 0.5 to –1, and relative stratigraphic height on the Y axis. Early igneous activity was dominated by basalts with negative ΔNb (N-MORB mantle source) with a change to positive ΔNb ('Icelandic' mantle source) occurring after less than 1 m.y. This change represents the first influx of chemically distinct plume mantle into the BTIP.

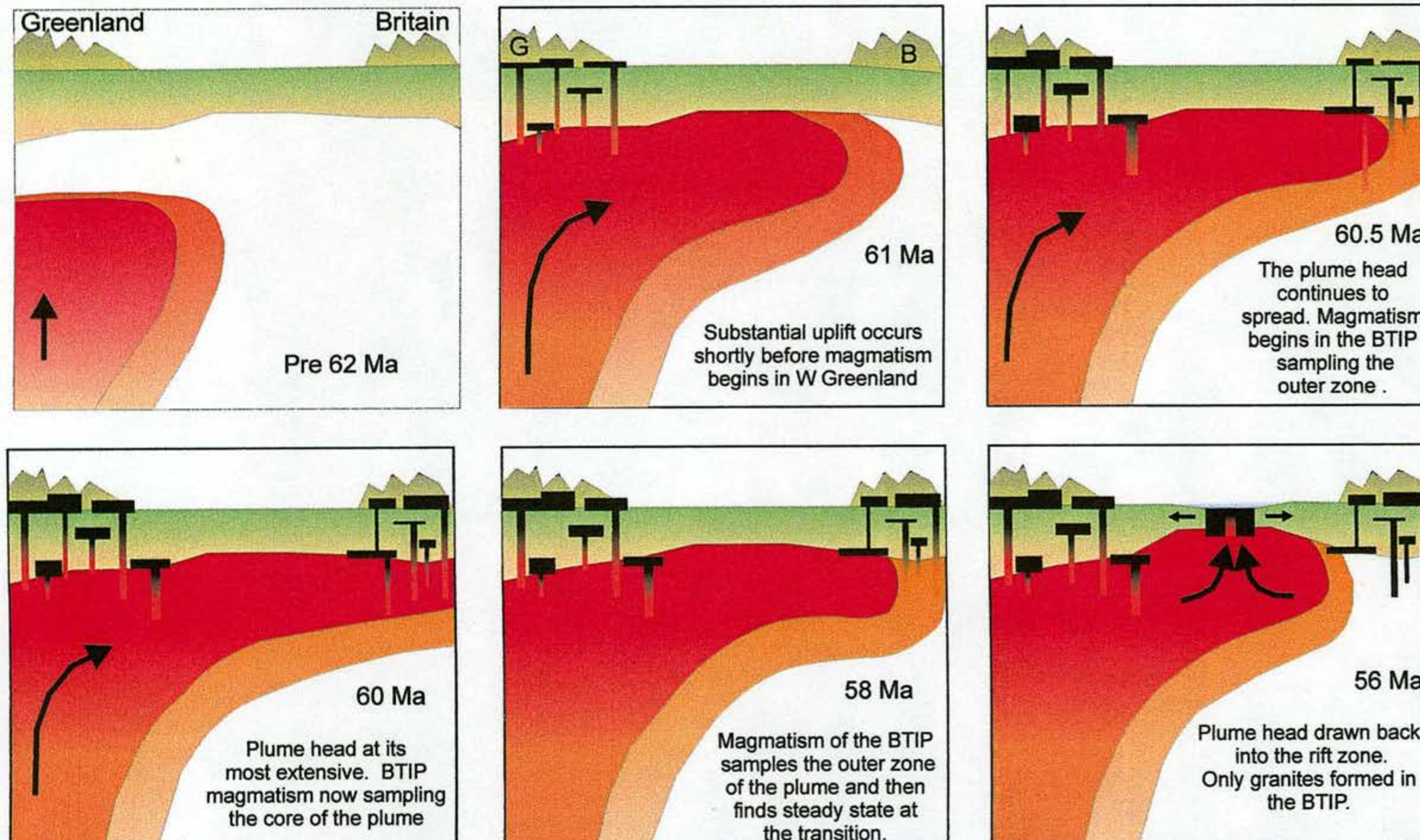


Figure 8.1. A schematic diagram showing the development of the BTIP with respect to the underlying mantle plume. The plume head spreads beneath the lithosphere before being drawn back towards the active zone of rifting. Basalts from the BTIP are shown to sample both 'Icelandic' (core) and hot N-MORB-like outer sheath mantle sources through time. The former probably originates in the lower mantle, possibly from the core-mantle boundary, while the latter originates in the thermal boundary layer at the base of the upper mantle.

Location	Sample No.	Sample	Age	Error	MSWD	Age type	Notes
Mull	B1	basal lava	60.56	0.29	14.88	plateau	
	BB6	basal lava	58.88	0.7	3.36	isochron	excess Ar
	T1	basal lava	61.36	0.2	53.99	TFA	discordant
	T3	basal lava	57.10	3.32	1	isochron	excess Ar
	BM64 & 67	700m	58.38	0.19	1.45	WMA	TFA ~59.5
	SO17 & 33	C1 lava	59.05	0.27	1.13	WMA	
	LB1	Loch Ba sanidine	58.48	0.18	3.05	plateau	
	MD1-3	dykes	58.12	0.13	0.42	WMA	
Skye	lavas	middle lavas	59.83	0.12	2.9	WMA	
	dykes	dykes cutting lavas	59.20	0.16	0.3	WMA	
	RGS	Rudha Stac granite	57.27	0.3	1.34	WMA	
	GG	Glamaig granite	60.54	0.65	2.61	plateau	
	LAG	Loch Ainort granite	58.58	0.13	2.04	WMA	
	MG	Marsco granite	56.40	0.29	2.47	WMA	
	GBMG	Glas Bheinn Mhor granite	55.26	0.42	4.82	WMA	
	BDG	Beinn an Dubhaich granite	55.44	0.22	7.03	WMA	
Antrim	Lower		61.02	0.08	9.06	WMA	
	Middle		60.07	0.06	1.77	WMA	
	AGH4	(Upper)	58.79	0.35	4.02	plateau	
	G1	Mourne	55.47	0.11	3.4	WMA	
Muck	MT2	basal tuff	60.65	0.07	0.75	WMA	
	MT2	basal tuff	60.19	0.2		U/Pb	
	MT3	basal tuff	60.44	0.07	0.12	WMA	
	T752	lava	59.12	2.41	1	isochron	excess Ar
	MKD1	dyke	58.58	1.59	11.52	isochron	excess Ar
Eigg	T908	lava	59.78	0.25	1.9	plateau	
	EP	Sgurr of Eigg	58.73	0.08	1.95	WMA	
	EPG	Sgurr of Eigg	47.14	0.12	87.05	WMA	
Rum	SR539	w. granophyre	61.13	0.32	4.1	WMA	
	SR475	w. granophyre	60.01	0.45	2.39	plateau	
	SR215	lava	60.28	0.82	5.12	isochron	saddle shape
Canna	SR252	lava	59.98	0.24	1.33	plateau	
	SR215 & 252		60.00	0.23	2.9	WMA	
Ardnamurchan	AN20	C1	59.14	0.19	3.4	plateau	
	AN11	C3	58.82	0.16	1.8	WMA	
Arran	A3	northern granite	57.85	0.15	5.67	WMA	
Rockall	57/13-66		57.03	0.21		TFA	discordant
Anton Dorhn	57/12-18		47.40	0.15		TFA	discordant
	57/12-18		54.03	0.17		TFA	discordant
Anglesey	3317		60.05	2.85	18.62	isochron	excess Ar
Beloc	KT	K-T tektite	64.81	0.03		WMA	

Table 8.1. A summary table of all of the $^{40}Ar/^{39}Ar$ ages (in Ma) presented in Chapter 4. WMA = weighted mean age; TFA = total fusion age. Details of these analyses and the sample names can be found in Appendix B or Chapter 4.

Appendices

Appendix A: Publications

A1 Chambers, L. M. & Fitton, J. G. 2000. Geochemical transitions in the ancestral Iceland plume: evidence from the Isle of Mull Tertiary volcano, Scotland. *Journal of the Geological Society of London,* **157**, 261-263.

A2 Chambers, L. M. & Pringle, M. S. (Submitted a, Science). Initiation of magmatism in the North Atlantic Igneous Province.

A3 Chambers, L. M. & Pringle, M. S. (Submitted b, EPSL). Age and duration of the Isle of Mull Tertiary volcano, Scotland, and the confirmation of subchrons during Anomaly 26r.

Appendix B: $^{40}Ar/^{39}Ar$ Geochronology

B1 Full $^{40}Ar/^{39}Ar$ experiment details

B2 $^{40}Ar/^{39}Ar$ sample lists

Appendix C: Geochemistry

C1 Sample lists

C2 XRF results

C3 $\delta^{18}O$ results

Journal of the Geological Society, London, Vol. **157**, 2000, pp. 261–263. Printed in Great Britain.

SPECIAL

Geochemical transitions in the ancestral Iceland plume: evidence from the Isle of Mull Tertiary volcano, Scotland

L. M. CHAMBERS & J. G. FITTON

Department of Geology & Geophysics, University of Edinburgh, West Mains Road, Edinburgh, EH9 3JW, UK (e-mail: Lynne.Chambers@glg.ed.ac.uk)

The Mull Tertiary volcano lies on the eastern edge of the North Atlantic Igneous Province, and was active soon after the initiation of the Iceland plume. Detailed sampling of the Mull lava pile has allowed temporal changes in the mantle source to be determined. A significant change at 700 m above sea level from N-MORB-like to 'Icelandic' marks the first arrival beneath the region of mantle from the core of the ancestral plume. The earlier basalts represent an outer plume sheath of heated upper mantle. From the initiation of magmatism in Mull, it took 1.9 ± 0.4 Ma for this transition to occur.

Keywords: Mull, Tertiary, Iceland plume, basalts, geochemistry.

The Mull plateau lava flows cover an area of 840 km^2 and have a thickness today of nearly 1000 m. Studies of zeolite minerals suggests that approximately 1000 m has been eroded from the top of the lava pile (Walker 1971). After the fissure-fed lava flows had covered the Tertiary landscape, a central volcanic complex developed. This complex comprised multiple cross-cutting arcuate intrusions concentrated around three centres of igneous activity (Centres 1–3) (Bailey *et al.* 1924). Lastly, the whole area was cut by the regional NW–SE-trending dyke swarm. This study is primarily concerned with the 1000 m of plateau lava flows of Ben More (Fig. 1).

The lava sequence in Mull has been subdivided into three groups by Kerr (1993); the Mull Plateau Group (MPG), the Coire Gorm magma type (CG) and the Central Mull tholeiites (CMT). The Mull Plateau Group makes up most of the succession with the Coire Gorm lava flows being found only at the highest point in the succession at the top of Ben More. The Central Mull Tholeiite flows are mostly found in the central complex as part of Centre 1. Here we present ΔNb (Fitton *et al.* 1997) data for all of the Mull lava sequence and discuss the implications for the composition and timing of the ancestral Iceland plume.

Results. Approximately 450 samples (collected from Mull by A. Kerr (Kerr 1993) with additional samples collected by the authors) covering all three lava groups and the late dykes

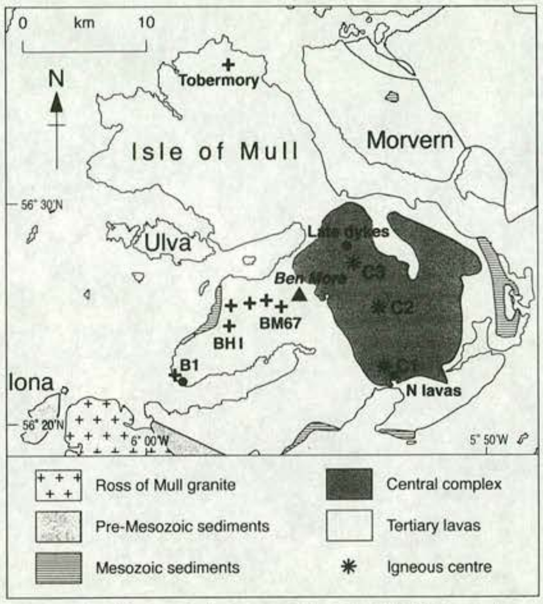


Fig. 1. A simplified geological map of the Isle of Mull. The sections sampled by Kerr (1993) are shown as crosses and the samples collected by the authors are shown as dots. The position of the three centres within the central volcano are marked and can be seen to move northwestwards with time.

were analysed by XRF spectrometry at the University of Edinburgh. Particular care was taken in the determination of Nb which is believed to be precise (2σ) to ±0.1 ppm for values <2 ppm and ±0.2 ppm for values >2 ppm. Analytical methods are described in Fitton *et al.* (1998). The data are plotted on a Nb/Y v. Zr/Y diagram (Fig. 2), which was used by Fitton *et al.* (1997) to distinguish modern Icelandic basalt from normal mid-ocean ridge basalt (N-MORB). Icelandic basalt and N-MORB define distinct and parallel arrays, showing that the Iceland array cannot represent mixing of plume and N-MORB mantle sources. Icelandic basalt and N-MORB can conveniently be distinguished through the excess or deficiency in Nb (ΔNb) using the lower boundary of the Iceland array as a reference line. The majority of the Mull samples plot below the Iceland array (negative ΔNb, in the N-MORB field) although the younger basalts plot within the array (positive ΔNb).

Distinguishing basalt with Icelandic and N-MORB sources is complicated by the effects of crustal contamination in the British Tertiary Igneous Province. Thompson *et al.* (1986) have shown that the earliest Mull basalts (the Staffa Group) could have assimilated 20–30% of Moine pelite, although Kerr *et al.* (1995) have shown that most of the Mull Plateau Group lavas are relatively uncontaminated and that the most contaminated contain only 3–5% of Lewisian granulite. Even after eliminating the most contaminated samples, however, the mantle source of British Tertiary Igneous Province basalts cannot be unambiguously deduced on the basis of $^{143}Nd/^{144}Nd$ and $^{87}Sr/^{86}Sr$ (Saunders *et al.* 1997). Pb isotopes separate out Icelandic basalt and Atlantic N-MORB into parallel arrays (Thirlwall 1995) but the addition of even very small amounts of crust again prevents Pb isotopes being of use in the British

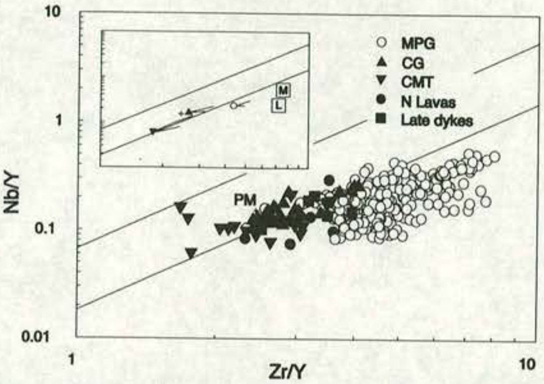


Fig. 2. Nb/Y v. Zr/Y for the Isle of Mull basalts. The samples have been subdivided after Kerr (1995); MPG, Mull Plateau Group; CG, Coire Gorm magma type; CMT, Central Mull Tholeiites. In addition, data from the N-lava flows (those with normal magnetic polarity from Centre 1; Dagley *et al.* 1987) and late dykes are included. The two parallel lines represent the Iceland array; PM, primitive mantle (from Fitton *et al.* 1997). N-MORB plots below the lower line, and ΔNb is the distance in log units above and below this reference line. The majority of the Mull samples plot in the N-MORB field, although some samples from each of the MPG, CG and CMT magma types plot within the Iceland array. The Mull samples define an array, extending from the Iceland field at low Zr/Y to the N-MORB field at high Zr/Y, because of a systematic variation in degree and depth of partial melting. The high-Zr/Y basalts represent small melt-fractions, generated under a thick lithosphere lid, of N-MORB-source mantle in the slightly cooler outer zone of the ancestral plume. The low-Zr/Y samples reflect larger degrees of melting of 'Icelandic' mantle in the hotter core of the plume, generated at a later time and possibly under a thinner lid. The inset diagram shows the effects of mixing 20% by mass of Lewisian granulite (L; Weaver & Tarney 1981) and Moine pelite (M; Thompson *et al.* 1986) with basalt representing the three principal magma types.

Tertiary Igneous Province. ΔNb is relatively insensitive to the effects of crustal contamination because crustal rocks plot close to or below the Iceland array reference line ($\Delta Nb \leq 0$; Fitton *et al.* 1997). Thus crustal contamination can only lower ΔNb and can never make a basalt with an N-MORB source appear to be Icelandic. This is illustrated in the inset diagram in Fig. 2 which shows the effects of mixing 20% by mass of Lewisian granulite (Weaver & Tarney 1981) and Moine pelite (Thompson *et al.*, 1986) with basalt representing the three principal magma types. These large levels of contamination only have a modest effect on ΔNb, especially in the case of contamination with Moine pelite (Fig. 2), but substantially increase the concentration of elements such as Ba that are much more abundant in crustal rocks than in the uncontaminated basalts. Ba/Zr, for example, increases typically by a factor of 2 with a Lewisian granulite contaminant and by a factor of 3 with Moine pelite. To limit the effects of contamination we have eliminated basalts with Ba/Zr>2 from our data set, and we are confident that ΔNb reflects only the mantle source composition.

The variation in ΔNb with stratigraphic height in the lava pile is shown in Fig. 3. The stratigraphic height of each sample is taken as its present height above sea level since the flows are nearly horizontal and the lava field in Mull is not cut by any major faults. The thickest section through the lava pile combines the Beinn na h-Iolaire and Ben More sequences of Kerr (1995). The Beinn na h-Iolaire section is up dip of the Ben More lava flows which dip gently at 2° to the east. A major change in ΔNb occurs at 700 m (Fig. 3) when the basalts change from having an N-MORB source (negative ΔNb) to having an 'Icelandic' source (positive ΔNb). This change occurs between samples BM67 and BM68. As any samples showing obvious effects of crustal contamination have been removed from Fig. 3, and there is no significant change in Ce/Y and Ba/Zr (not shown) at this level, this transition in ΔNb cannot be attributed to variation in the amount of assimilated crust.

The stratigraphic section in Fig. 3 also shows the other changes in basalt composition noted by Kerr (1993). The

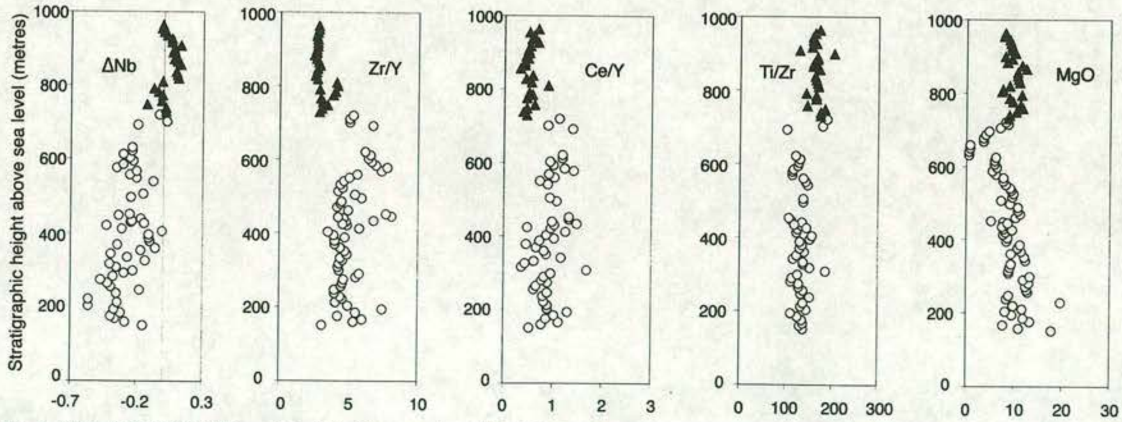


Fig. 3. ΔNb, Zr/Y, Ce/Y, Ti/Zr and MgO (wt%) v. stratigraphic height (metres above sea level) in the Mull lava succession. The MPG are shown as open circles and the CG as filled triangles, as in Fig. 2. The ΔNb trend shows the change from an N-MORB to an 'Icelandic' mantle source at 700 m. The magma type fluctuates over the next nine flows until approximately 820 m. The MgO plot illustrates how, before the CG lava sequence was erupted, MgO decreased as the magma evolved (Kerr 1993). These evolved lavas (MgO <4 wt%) have been eliminated from the other plots.

change in ΔNb is almost coincident with the boundary between the Mull Plateau Group and the Coire Gorm basalt types. Kerr's (1993) subdivision is based on the difference in Ti/Zr, and on the Mull Plateau Group having LREE-enriched patterns compared with the Coire Gorm flows, which have flat REE patterns. ΔNb shows that the two magma types have different mantle sources. In addition, the Zr/Y plot shows that the Coire Gorm lavas are slightly less enriched than the Mull Plateau Group, implying a larger degree of melting. A larger degree of melting of a less depleted mantle source can also explain the difference in REE patterns noted by Kerr (1993).

Figure 3 shows that low-pressure fractional crystallization can be eliminated as a cause of the variation because the plot of wt% MgO with height shows no correlation with the other parameters. Samples with<4wt% MgO are confined to the later lava flows of the Mull Plateau Group, when magma supply was dwindling. If these samples are eliminated, the MgO contents of the Mull Plateau Group and Coire Gorm lavas are very similar. The samples with MgO <4wt% have been removed from the other plots in Fig. 3 and in Fig. 2. The higher MgO content of the Coire Gorm lava flows compared to the evolved Mull Plateau Group, shows that the Coire Gorm flows represent a new influx of basic magma.

The transition from negative to positive ΔNb at 700 m marks the first appearance of 'Icelandic' basalts in the Ben More sequence. ΔNb fluctuates between positive and negative values until sample BM83 at 820 m. After this point only the 'Icelandic' source is sampled until the last two flows where ΔNb again becomes negative. The Central Mull Tholeiites and the N-lavas (lava flows from the central complex with normal magnetic polarity) plot in the N-MORB array (Fig. 2). Therefore the geochemical trend in the lava flows of Mull is N-MORB-like to 'Icelandic', and then back to N-MORB-like. The Mull lava sequence has been dated by $^{40}Ar/^{39}Ar$ and this indicates that the whole Tertiary igneous sequence in Mull took only 3 Ma to form (L. M. Chambers & M. S. Pringle unpublished data). The base of the lava sequence (B1) was dated at 60.56 ± 0.3 Ma (1σ) and the geochemical transition at BM67 at 58.66 ± 0.25 Ma (1σ). Therefore it took 1.9 ± 0.4 Ma to form 700 m of basalt and for the basalt to change from N-MORB-like to 'Icelandic'.

Conclusions. Major geochemical changes in the ancestral Iceland plume have been recorded in the Isle of Mull Tertiary plateau lavas and central volcano. The first 700 m of lava flows still preserved in Mull were sampling the relatively cool outer N-MORB part of the ancestral Iceland plume. As supply diminished these magmas started to fractionate and evolve. At 700 m (1.9 Ma after the earliest magmatism) the first influx of 'Icelandic' magma reached the surface. The basalts were now sampling the hotter inner zone of the ancestral plume. The decrease in Zr/Y at this point (Fig. 2) reflects an increase in the degree of melting. The two types seem to alternate for 120 m or nine flows until the 'Icelandic' magma dominated. The top two preserved flows suggest that N-MORB was becoming dominant again in this part of the BTIP. This is confirmed by the lava flows in the central complex which are also N-MORB-like. The basic igneous rocks of Mull therefore provide a record of the initiation and spread of the Iceland plume at about 60 Ma. They strengthen the hypothesis (Fitton *et al.* 1997) that the plume head was zoned, with an outer sheath of hot ambient upper mantle surrounding a core of 'Icelandic' mantle. The data we present suggest that ΔNb is a powerful tool in defining the mantle source of the British Tertiary Igneous Province magmas. This was previously impossible as Sr-, Nd- and Pb-isotope ratios are affected by contamination with continental crust.

This work was carried out as part of a NERC-funded PhD project (GT4/96/87/E). Rock samples and pressed powder pellets were supplied by A. Kerr and P. Dagley. M. Pringle and B. Hardarson are thanked for helpful discussion and L. Newcombe for assistance in the field. The constructive comments of J. Baker, R. Taylor and an anonymous referee are also acknowledged.

References

BAILEY, E.B., CLOUGH, C.T. & WRIGHT, W.B. 1924. *Tertiary and Post-Tertiary Geology of Mull, Loch Aline and Oban.* Memoir of the Geological Survey of Great Britain, HMSO Edinburgh.

DAGLEY, P., MUSSETT, A.E. & SKELHORN, R.R. 1987. Polarity, stratigraphy and duration of the Tertiary igneous activity of Mull, Scotland. *Journal of the Geological Society, London*, **144**, 985–996.

FITTON, J.G., SAUNDERS, A.D., LARSEN, L.M., HARDARSON, B.S. & NORRY, M.J. 1998. Volcanic rocks from the southeast Greenland margin at 63 N: composition, petrogenesis and mantle sources. *Proceedings of the Ocean Drilling Program, Scientific Results*, **152**, 331–350,

——, ——, NORRY, M.J., HARDARSON, B.S. & TAYLOR, R.N. 1997. Thermal and chemical structure of the Iceland plume. *Earth and Planetary Science Letters*, **153**, 197–208.

KERR, A.C. 1993. *The geochemistry and petrogenesis of the Mull and Morvern Tertiary lava succession, Argyll, Scotland.* PhD Thesis University of Durham.

—— 1995. The geochemical stratigraphy, field relations and temporal variation of the Mull-Morvern Tertiary lava succession, NW Scotland. *Transactions of the Royal Society of Edinburgh: Earth Sciences*, **86**, 35–47.

——, KEMPTON, P.D. & THOMPSON, R.N. 1995. Crustal assimilation during turbulent magma ascent (ATA); new isotopic evidence from the Mull Tertiary lava succession, NW Scotland. *Contributions to Mineralogy and Petrology*, **119**, 142–154.

SAUNDERS, A.D., FITTON, J.G., KERR, A.C., NORRY, M.J. & KENT, R.W. 1997. The North Atlantic Igneous Province. *In*: MAHONEY, J.J. & COFFIN, M.F. (eds) *Large igneous provinces*, American Geophysical Union Monographs, **100**, 45–94.

THIRLWALL, M.F. 1995. Generation of the Pb isotopic characteristics of the Iceland plume. *Journal of the Geological Society, London*, **152**, 991–996.

THOMPSON, R.N., MORRISON, M.A., DICKIN, A.P., GIBSON, I.L. & HARMON, R.S. 1986. Two contrasting styles of interaction between basic magmas and continental crust in the British Tertiary Volcanic Province. *Journal of Geophysical Research*, **91**, 5985–5997.

WALKER, G.P.L. 1971. The distribution of amygdale minerals in Mull and Morvern (western Scotland). *In*: MURTY, T.V.V.G.G.R.K AND ROA, S.S. (eds) *Studies in Earth Sciences*, W. D. West commemorative volume, 181–194.

WEAVER, B.L. & TARNEY, J. 1981. Lewisian gneiss geochemistry and Archaean crustal development models. *Earth and Planetary Science Letters*, **55**, 171–180.

Received 13 August 1999; revised typescript accepted 11 October 1999.
Scientific editing by Nick Rogers.

Initiation of magmatism in the North Atlantic Igneous Province

LYNNE M. CHAMBERS[1] and MALCOLM S. PRINGLE[2]

[1] *Department of Geology and Geophysics, University of Edinburgh, West Mains Road, Edinburgh, EH9 3JW, UK.*

[2] *Scottish Universities Environmental Research Centre, Rankine Avenue, Scottish Enterprise Technology Park, East Kilbride, Glasgow G75 0QF, UK.*

The relative chronology of magmatic and tectonic events is key to an understanding of the influence of the Iceland plume on the North Atlantic. In particular, the location and duration of magmatism during the early development of the plume is of fundamental importance. Initial widespread flood basalt formation occurred in Baffin Island, Greenland and Britain before complete plate break up at 56 Ma after which time magmatism became concentrated in the zone of active rifting.

Historically the British Tertiary Volcanic Province has been instrumental in advancing many concepts of igneous petrology. However, the absolute age and duration of the province remains unresolved. We present new internally consistent $^{40}Ar/^{39}Ar$ ages that constrain the duration of igneous activity in the British province to 3 m.y. and discuss the implications that these ages have for the whole North Atlantic in particular the timing and location of initial magmatism.

Keywords: Absolute ages; $^{40}Ar/^{39}Ar$; timescale; Scotland; Tertiary

Introduction

The rapid erosion and subsequent magmatism seen in the British Tertiary

Volcanic Province (BTVP) has been linked to the impingement of the ancestral Iceland plume on the base of the lithosphere in the North Atlantic region. The British Tertiary Igneous Province is composed of numerous igneous centres with early plateau lava successions cross cut by central plutonic complexes and the NW-SE trending dyke swarm. Stratigraphic relationships within each igneous centre are well defined allowing the order of formation to be determined (Emeleus and Gyopari, 1992). Unfortunately, very few cross cutting relationships exist between igneous centres making relative correlation difficult.

Radiometric ages for the BTVP are summarised in Table 1 and range from 62.8 Ma, for the earliest plateau lavas (tuff horizons dated by Pearson *et al.*, 1996) through to a 52.1 Ma Rb-Sr isochron age for the Sgurr of Eigg pitchstone (Dickin and Jones, 1983). Therefore, prior to this study the BTVP was thought to have formed during a 10 Ma period with the bulk of magmatism occurring between 62 Ma and 57 Ma (Mussett *et al.*, 1988; Pearson *et al.*, 1996).

We present $^{40}Ar/^{39}Ar$ ages for the two Muck tuffs and the Sgurr of Eigg pitchstone in addition to new ages for Skye and Mull (Chambers and Pringle, submitted). This work suggests that the whole of the BTVP formed within 3 m.y. commencing around 60.5 Ma.

Methodology

Individual sanidine crystals were separated from the two Muck tuffs and Eigg pitchstone sample for $^{40}Ar/^{39}Ar$ dating at SUERC, East Kilbride. The sanidine samples were leached in warm (~50°C) 6M HCl for 20 minutes and the Muck tuff samples (MT2 & 3) were also leached in cold 1M HF for 10 minutes, in order to remove any remaining oxidised glass groundmass. A split of each of the MT2 and MT3 samples were then loaded into copper packets and irradiated in Oregon (more details can be found in Chambers and Pringle, submitted). A second split of the MT2 sample was handpicked, the individual crystals loaded into copper trays and then irradiated at the Petten Rodeo reactor for three hours. The individual crystals were then analysed by laser total-fusion and incremental-heating analysis with a CO_2 laser on a Map 215/50 rare gas mass spectrometer (Map 2). Once irradiated, the MT2 and MT3 samples plus the appropriate sanidine standards were removed from the copper packets and loaded into copper trays for analysis on another Map 215 rare gas mass spectrometer (Map 1). Individual crystals of sanidine and glass were hand picked from the Sgurr of Eigg pitchstone, loaded into copper trays and then irradiated at the Petten Rodeo reactor for three hours. The flux standard J was monitored in every copper tray, and at 20mm height intervals in the Oregon irradiation, using the USGS standard sanidine 85G003 at 27.92 ± 0.04 Ma and Fish Canyon Tuff sanidine at 27.61 Ma.

Results

To be accepted as valid estimates of crystallization ages the results presented here must meet the rigorous selection criteria of Pringle (1992) and Singer and Pringle (1997). All of the results and the weighted mean ages can be found in Table 2, any experiments that failed the selection criteria are shown in *italics*.

The two Muck tuff samples (MT2 and MT3) were analysed in two batches by laser total-fusion, with a total of 24 crystals giving an isochron age of 60.66 ±0.15 Ma for Muck tuff 2 and 24 crystals giving an age of 60.50 ±0.13 Ma for Muck tuff 3. The freshest of these sanidines, from Muck tuff 2, was additionally analysed using laser step-heating and total-fusion analysis, these results are shown in Table 2. The individual step-heating experiments gave a weighted mean age of 60.60 ±0.11 Ma for Muck tuff 2 (MT2) and the total-fusion of 13 crystals gave an age of 60.53 ±0.18 Ma. Sample MT3 was also analysed by incremental-heating analysis, the results of which are shown in Table 2, gave a combined age of 60.42 ±0.09 Ma. Final weighted mean ages of 60.65 ±0.07 Ma for the Muck tuff 2 sample and 60.44 ±0.07 Ma for the Muck tuff 3 sample are obtained using all of the individual experiments. Figure 1 shows example age spectra for the two tuff samples.

Sgurr of Eigg Pitchstone

Sanidine and glass samples from the Sgurr of Eigg pitchstone were analysed by laser incremental-heating, with a second sample of the sanidine analysed by laser total-fusion. Incremental-heating experiments on the Eigg sanidine gave a weighted mean age of 58.73 ±0.08 Ma, and the total-fusion experiments a weighted mean age of 58.67 ±0.18 Ma. A combined age of 58.72 ±0.07 Ma is used for the sanidine from the Sgurr of Eigg, based on a weighted mean age from all of the sanidine experiments. In contrast to the sanidine ages, the glass from the pitchstone gave much younger plateau ages of 47.80 ±0.34 Ma and 50.39 ±0.59 Ma. These two step-heating experiments give a weighted-mean age of 48.45 ±0.29 Ma for the glass. The difference in age between the sanidine and the glass from the Sgurr of Eigg pitchstone, and the disturbed age spectra for the glass, suggests that the glass has been altered. The results from these experiments are summarised in Table 2 and can be found in full in the appendix. The Dickin and Jones (1983) Rb-Sr isochron age of 52.1 Ma used the sanidine, glass and a whole rock sample to construct the isochron. The young and non-repeatable ages fort he glass samples form the Sgurr of Eigg provides an explanation of why there is a discrepancy between the Rb-Sr isochron and the new sanidine $^{40}Ar/^{39}Ar$ ages presented here. If either the K or Ar has been mobilised, as indicated by the young glass ages and the age spectra (Figure 1), then it is entirely possible that the Rb and Sr have also been mobilised, thus rendering the Dickin and Jones (1983) isochron unreliable.

Discussion

The discrepancy between the Pearson *et al.* (1996) ages for the two Muck tuffs and the ages presented here is not so easily explained. Pearson *et al.* (1996) dated one crystal by laser incremental-heating from each of the Muck tuff samples and obtained $^{40}Ar/^{39}Ar$ ages using the standard MMhb at 520.4 Ma (Samson and Alexander, 1987). The ages presented here use the USGS sanidine standard 85003 at 27.92 Ma, which is relative to the USGS K-Ar biotite standard SB3 at

162.9 Ma. This age for SB3 would correspond to an age of 514.0 for MMhb (Pringle, 1992). Our age for the Muck tuffs would be 61.48 Ma and 61.31 Ma if we used the MMhb standard at 520.4 Ma as used by Pearson *et al.* (1996). The discrepancy of 2.2 m.y. is therefore too great to be explained by recalibration of the ages to the same standard.

As the $^{40}Ar/^{39}Ar$ dating technique relies on the known age of the standard, samples of the K-T tektite are also analysed along with the unknowns for use as an additional check. During this work a weighted-mean age for the K-T tektite was found to be 64.813 ± 0.03Ma, which corresponds to the value of 65.00 Ma used in the presently accepted time scales of Berggren *et al.* (1995) and Cande and Kent (1995). We believe that the weighted mean ages of 60.61 ±0.08 Ma and 60.45 ±0.07 Ma based on a total of 70 crystals dated by total-fusion and laser incremental-heating (using the USGS sanidine standard 85003 at 27.92 Ma) are now the most reliable ages available for the Muck tuffs. This age for the Muck tuffs is further reinforced by an absolute U/Pb age of 60.19 ±0.2 Ma on sphene from Muck tuff 2 (Chambers, Parrish and Pringle, unpublished data). The U/Pb age is not relative to any standards and provides an absolute tie point for the $^{40}Ar/^{39}Ar$ ages presented here.

As the K-T tektite is a calibration or tie point for the geomagnetic timescale, the new ages for the BTVP presented here can be directly placed within the timescale. The Muck tuffs are now known to occur within Chron 26r (60.92-57.91 Ma, Berggren *et al.,* 1995) rather than Chron 27r as previously believed. The Sgurr of Eigg pitchstone now occurs during Chron 26r and not Chron 23r and can no longer be assumed to be the youngest igneous event in the province. On the basis of the new $^{40}Ar/^{39}Ar$ ages the Eastern Redhills of Skye (Chambers and Pringle submitted) and the Mourne Mountains in Ireland (Chambers, unpublished data) now appear to be the youngest events in the British province.

Confining the duration of igneous activity in the BTVP to 3 m.y. has implications for the relative timing of the North Atlantic Igneous Province. Previous age dates from the BTVP, the new ages presented here, ages for west and other rocks from the NAIP are plotted on the magnetic timescale of Berggren *et al.* (1995) (Figure 2). The Muck lavas, dated via the interbedded sanidine bearing tuffs, have reversed polarity as do the majority of samples from the BTVP, however early lava flows at the base of the West Greenland succession (Vaigat Formation) have normal magnetic polarity (Hald, 1977; Riisager and Abrahamsen, 1998). Reversed polarity lavas from higher in the Vaigat Formation with an age of 60.5 Ma (Storey *et al.*, 1998) plot within Chron 26r, implying that the lower lava flows with normal polarity plot in Chron 27n. As Muck is now known to be the same age as the reversed lava succession in the Vaigat Formation (Figure 2), the normal polarity lavas at the base of the Greenland succession are now believed to be the first onshore manifestation of the ancestral plume in the North Atlantic.

As the majority of volcanism in the BTVP and other onshore areas of the NAIP occurred during the 3 m.y. period corresponding to Chron 26r (Figure 2) reversals in magnetic polarity seen in the BTVP has consequences for the geomagnetic timescale. The well-defined stratigraphic relationships within the BTVP have allowed a detailed determination of the changes in magnetic polarity to be made (Dagley and Mussett, 1986; Dagley and Mussett, 1981; Dagley *et al.*, 1987; Dagley *et al.*, 1990). In Skye, for example, there are no fewer than seven recorded changes in magnetic polarity (Dagley *et al.*, 1990). The new ages presented here and the ages in Chambers and Pringle (submitted) show that all of these reversals occur during 26R. As the Ar-Ar ages presented here and in Chambers and Pringle (submitted) are all internally consistent and correlate to the K-T boundary, these changes in polarity within 26r have to be accounted for. One possible explanation involves the pattern of tiny wiggles recorded in seafloor spreading records described by Cande and Kent (1992a and b) as cryptochrons. Seven of these wiggles can be seen in Chron 26r. However, Cande and Kent (1992b) conclude that these were changes in intensity and not true changes in polarity. Our work in the BTVP suggests that the changes in polarity recorded in the BTVP, now known to occur within Chron 26r, means that some of the cryptochrons described by Cande and Kent (1992a and 1995) could be true reversals and not intensity changes.

The later normal events found in the BTVP, for example the formation of Centres 2 and 3 in the Mull volcano, involve large numbers of intrusions and the development of large central volcanoes which means that they are unlikely to record short cryptochrons (30,000 years in duration). A second explanation is simply that the larger events are formed during 26n. This is possible because the K-T boundary is a well calibrated tie point whereas the Palaeocene Eocene boundary is not (Berggren *et al.*, 1995). As the position of the polarity intervals are calculated using constant seafloor spreading rates between these two tie points it is entirely possible that by accurately calibrating the P-E boundary the position of 26n would move. This does not however account for all of the smaller igneous events that record other earlier changes in polarity during Chron 26r (Chambers and Pringle, submitted). The existence of at least two cryptochrons within Chron 26r are still required to satisfy the changes in magnetic polarity recorded in the BTIP.

Conclusions

Rapid eruption of the BTVP occurred in 3 m.y., beginning simultaneously in most areas at about 60.5 Ma. The Eigg Lava Formation dated by a sanidine bearing tuff layer is now considered to be 60.5 Ma and not 62.8 Ma as previously published (Pearson *et al.*, 1996). The lowest lavas of the Vaigat formation in Greenland, with normal magnetic polarity, are therefore the oldest rocks so far indirectly dated from the NAIP. This is consistent with a plume centred towards Greenland. Early magmatism occurred later in localised thinspots during Chron 26r (Thompson and Gibson, 1991). In the BTVP itself all volcanism had ceased by the time of break up at 56 Ma.

The dating of the Sgurr of Eigg pitchstone has constrained the duration of the BTVP to be 3 m.y. and not 10 Ma as previously suggested. The 3 m.y. duration includes the formation of the central volcanoes. This implies that the early plateau lava successions formed much more rapidly than previously believed. In Mull, for example, lava eruption occurred for 1.51 Ma $\pm$ 0.4 (Chambers and Pringle, submitted). The total minimum volume of plateau lava flows is estimated at 5800 km^3. This corresponds to an eruption rate of 2.93 $x10^{-3}$ km^3/yr, assuming a maximum duration of 2 m.y. with steady state eruption. The volume of the plateau lava flows in the BTVP (5800 km^3) is an order of magnitude lower than in West Greenland and Baffin Island (55,000km^3, Saunders *et al.*, 1997), which may relate to the location of the BTVP at the more distal edges of the ancestral plume.

Acknowledgements

Godfrey Fitton and Lee Newcombe are thanked for helpful discussion. This work forms part of a NERC funded PhD (GT4/96/87/E). Correspondence to L. M. Chambers (e-mail: Lynne.Chambers@glg.ed.ac.uk).

References

Berggren, W.A., Kent, D. V., Swisher, C.C. & Aubry, M-P. 1995. A revised Cenozoic geochronology and chronostratigraphy. In: Geochronology, time scales and global stratigraphic correlation, Society for Sedimentary Geology Special Publication, 54, 129-212.

Blakely, R. J. 1974. Geomagnetic reversals and crustal spreading rates during the Miocene. Journal of Geophysics Research, 70, 2979-2985.

Cande, S. C. & Kent, D. V. 1992a. Ultrahigh resolution marine magnetic anomaly profiles: a record of continuous paleointensity variations? Journal of Geophysical Research, 97, 15,075-15,083.

Cande, S. C. & Kent, D. V. 1992b. A new geomagnetic polarity time scale for the Late Cretaceous and Cenozoic. Journal of Geophysical Research, 97, 13,917-

13,951.

Cande, S. C. & Kent, D. V. 1995. Revised calibration of the geomagnetic polarity timescale for the Late Cretaceous and Cenozoic. Journal of Geophysical Research, 100, 6093-6095.

Chambers, L. M. and Pringle, M. S. (submitted). Age and duration of the Isle of Mull Tertiary volcano, Scotland, and the confirmation of subchrons during Anomaly 26r.

Dagley, P. and Mussett, A. E. 1986. Palaeomagnetism and radiometric dating of the British Tertiary Igneous Province: Muck and Eigg. Geophys. J. R. astr. Soc., 85, p 221-242.

Dagley, P. and Mussett, A. E. 1981. Palaeomagnetism of the British Tertiary Igneous Province: Rhum and Canna. Geophys. J. R. astr. Soc., 65, p 475-491.

Dagley, P., Mussett, A. E. and Skelhorn, R.R. 1987. Polarity, stratigraphy and duration of the Tertiary igneous activity of Mull, Scotland. Journal of the Geological Society, London, 144, p 985-996.

Dagley P., Mussett, A. E. and Skelhorn, R.R. 1990. Magnetic polarity stratigraphy of the Tertiary igneous rocks of Skye, Scotland. Journal of Geophysics research international, 101, p395-409.

Dickin, A. P. and Jones, N. W. 1983. Isotopic evidence for the age and origin of the pitchstones and felsites, Isle of Eigg, NW Scotland. Journal Geological Society, London, 140, 691-700.

Emeleus, C. H. and Gyopari, M. C. 1992. British Tertiary Volcanic Province. Chapman and Hall.

Emeleus, C. H., Allwright, E. A., Kerr, A. C. and Williamson, I. T. 1996. Red tuffs in the Palaeocene lava successions of the Inner Hebrides. Scottish Journal of Geology, 32, p83-9

Hald, N. 1977. Normally magnetised lower Tertiary lavas on Nûgssuaq, central West Greenland. Rapp. Gronlands Geol. Unders., 79, 5-7.

Hamilton, M. A., Pearson, D. G., Thompson, R. N., Kelley, S. P. and Emeleus, C. H. 1998. Rapid eruption of Skye lavas inferred from precise U-Pb and Ar-Ar dating of the Rum and Cuillin complexes. Nature, 394, 260-263.

Lawver, L.A. and Muller, R.D. 1994. Iceland hotspot track. Geology v22, 311-314.

Mussett, A. E. 1986. 40Ar-39Ar incremental-heating ages of the Tertiary igneous rocks of Mull, Scotland. Journal of the Geological Society, London, v143, p 887-896.

Mussett, A. E., Dagley, P. and Skelhorn, R.R. 1988. Time and duration of activity in the British Tertiary Igneous Province. From Morton, A. C. and Parson, L. M. (Eds.) early Tertiary Volcanism and the Opening of the NE Atlantic, Geological Society Special Publication 39, p 337-348.

Mussett, A. E., Dagley, P. and Skelhorn, R.R. 1980. Magnetostratigraphy of the Tertiary igneous succession of Mull, Scotland. Journal of the Geological Society, London, 137, p 349-357.

Pearson, D. G., Emeleus, C. H. and Kelley S. P. 1996. Precise $^{40}Ar/^{39}Ar$ age for the initiation of Palaeogene volcanism in the Inner Hebrides and its regional significance. Journal of the geological Society, London, 153, p 815- 818.

Pringle, M. P. 1992. Radiometric ages of basaltic basement recovered at sites 800,801 and 802, leg 129, western Pacific Ocean. Proceedings of the Ocean Drilling program, scientific results, 129.

Pringle, M. S. 1993. Age progressive volcanism in the Musicians seamounts: a test of the hot spot hypothesis for the late Cretaceous Pacific. In: Pringle, M. S., Sager, W. W., Sliter, W. V. & Stein, S. (Ed.) The Mesozoic Pacific geology, tectonics and volcanism. Am. Geophys. Union. Geophys. Monogr, 77, 187-215.

Riisager, P. and Abrahamsen, N. in press. Magnetostratigraphy of Paleocene basalts from the Vaigat Formation of west Greenland. Geophys. J. Int.

Saunders, A. D., Fitton, J. G., Kerr, A. C., Norry, M. J. and Kent, R. W. 1997. The North Atlantic Igneous Province. From Mahoney, J. J. and Coffin, M. F., Large Igneous Provinces. AGU Monograph, in press.

Singer, B. S. & Pringle, M. S. 1996. Age and duration of the Matuyama-Brunhes geomagnetic polarity reversal from $^{40}Ar/^{39}Ar$ incremental-heating analysis of lavas. Earth and Planetary Science Letters, 139, 47-61.

Sinton, C.W., Hitchen, K. and Duncan, R. A. 1998. $^{40}Ar/^{39}Ar$ geochronology of acidic and basic lavas on the margins of the North Atlantic.

Storey, M., Duncan, R. A., Pedersen, A. K., Larsen, L.M. and Larsen H. C. 1998. $^{40}Ar/^{39}Ar$ geochronology of the west Greenland Tertiary volcanic province. EPSL.

Thompson, R. N. and Gibson, S. A. 1991. Subcontinental mantle plumes, hotspots and pre-existing thinspots. J. Geological Society, London, 148, 973-977.

Figure captions

Table 1. A summary of available radiometric ages for the BTVP before this study.

Table 2. A table summarising the ages for the Muck tuffs and the Sgurr of Eigg pitchstone. Individual experiments are listed and weighted mean ages calculated and shown in bold. All of the $^{40}Ar/^{39}Ar$ ages presented here are relative to the USGS standard sanidine 85003 at 27.92 Ma and the K-T boundary at 64.813 ±0.03Ma.

Figure 1. Representative age spectra diagrams for the two Muck tuffs (2 and 3) and the sanidine and glass from the Sgurr of Eigg. Arrows show the steps used in the plateau age calculation. All ages are shown with errors of ± 2 standard deviations. The young age for the glass from the Sgurr of Eigg compared to the sanidine age shows that the glass is altered on a scale that was not visible on a Scanning electron microscope. All ages shown here are relative to the USGS standard sanidine 85005 at 27.92 Ma and the K-T boundary at 64.813 ±0.03Ma.

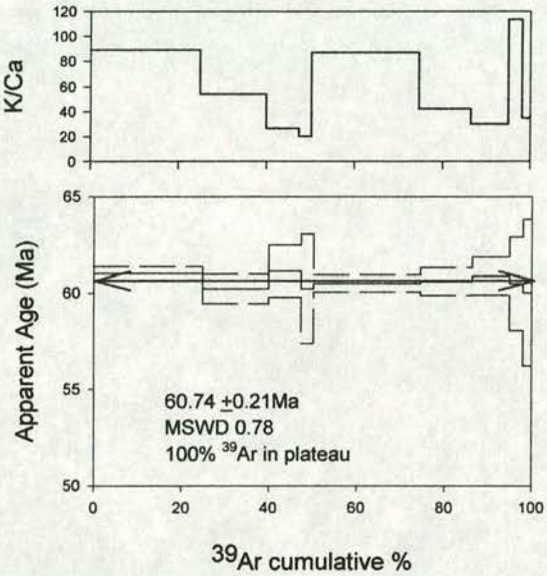
Figure 2. A schematic diagram showing the timescale of Berggren *et al.* (1995) and the latest ages for the BTVP. Ages for other areas in the NAIP are shown. The ages for the BTVP begin at 60.5 Ma and end at ~58 Ma. The Dickin and Jones (1983) Rb-Sr age for the Sgurr of Eigg pitchstone is shown for comparison.

By refining the duration of the BTVP, the earliest manifestation of the Iceland plume can be seen to be in West Greenland (Storey *et al.*, 1998; Sinton *et al.*, 1998) nearer to the proposed plume centre. The Palaeocene-Eocene boundary is shown at 55 Ma but with the errors included.

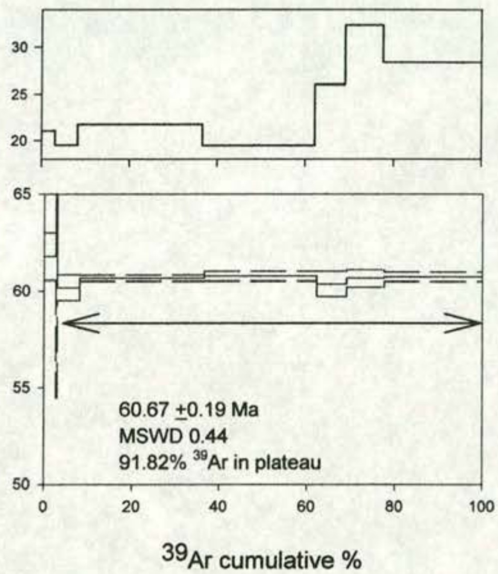
Location	Rock type	Details	Age	Error	Type	Reference
Muck	lavas	basal	63.00	3.40	Ar-Ar	Dagley and Mussett, 1986
	sanidine	Nr base of lavas	62.80	0.60	Ar-Ar	Pearson *et al*, 1996
	sanidine	Nr base of lavas	62.40	0.60	Ar-Ar	Pearson *et al*, 1996
Eigg	pitchstone	An Sgurr	52.10	0.50	Rb-Sr	Dickin and Jones, 1983
	lava	base lavas Eigg	63.30	1.80	Ar-Ar	Dagley and Mussett, 1986
Rum	granophyre	Western Rhum	59.80	0.40	Ar-Ar	Mussett, 1984
	lava		61.40	0.40	Ar-Ar	Mussett, 1984
	peridotite	layered complex	60.53	0.08	U/Pb	Hamilton *et al*,1998
Ardnamurchan		C3	60.00	1.70	Rb-Sr	Beckinsdale and Walsh
		C3	60.50	2.00	K-Ar	Michell and Reen, 1972
Mull	felsite	Loch Ba	56.50	1.00	Ar-Ar	Mussett, 1986
	granite C3		58.20	1.30	Rb-Sr	Walsh *et al*, 1979
	lavas		60.00	0.50	Ar-Ar	Mussett, 1986
Skye	whole/fspar	Beinn an Dubhaich	53.50	0.40	Rb-Sr	Dickin, 1981
	gabbro	Cuillins	58.91	0.07	U/Pb	Hamilton *et al*, 1998
	sill		54.90	0.60	Ar-Ar	Mussett *et al*, 1988
	granite	Loch Ainhort Granite	58.70	0.90	Rb-Sr	Dickin, 1981
	feldspar	Coire Uaigneich granite	59.30	0.70	Rb-Sr	Dickin, 1981
Arran	qtz porph	dykes	58.50	0.80	Ar-Ar	Mussett *et al*, 1987
	granite	northern	60.30	0.80	Rb-Sr	Dickin *et al*, 1981
	granite	northern	60.30	0.60	Ar-Ar	Evans *et al*, 1973
Antrim	gabbro	early	58.70	1.20	Ar-Ar	Thompson, 1986
	Granite	Mourne G1	56.20	0.70	Ar-Ar	Gibson *et al*,1995
	Granite	Mourne G2	58.10	1.60	Ar-Ar	Evans *et al*, 1973
	Granite	Mourne G2	54.90	1.20	Ar-Ar	Thompson *et al*, 1987
	Granite	Mourne G3	56.40	0.10	Ar-Ar	Gibson *et al*,1995
	Granite	Mourne G4	56.00	0.40	Ar-Ar	Gibson *et al*, 1995
	Granite	Mourne G4	54.50	0.80	Ar-Ar	Thompson *et al*, 1987
	Granite	Mourne G5	58.00	1.60	Ar-Ar	Evans *et al*, 1973
	Granite	Mourne G5	54.60	1.00	Ar-Ar	Gibson *et al*, 1995
		dyke cutting Mourne G5	53.10	1.00	Ar-Ar	Thompson *et al*, 1987
	Granophyre	Carlingford	60.90	0.50	Ar-Ar	Thompson, 1986
	Rhyolite	Tardree	60.70	0.60	Ar-Ar	In Meighan *et al*, 1988
	Granite	Mourne G1	56.40	1.40	U/Pb	Gamble *et al*, 1999
	Granite	Mourne G2	55.30	0.80	U/Pb	Gamble *et al*, 1999
	Granite	Slieve Gullion	56.50	1.30	U/Pb	Gamble *et al*, 1999
	Obsidian	Tardree	58.40	0.70	U/Pb	Gamble *et al*, 1999
	Obsidian	Sandy Braes	59.00		Ar-Ar	Thompson *et al*, 1984
	dyke	Blind rock	61.70	0.50	Ar-Ar	Thompson, 1986
	Rhyolite	Tardree	64.60	5.00	fisson	Fitch and Hurford, 1977
	Rhyolite	Tardree	65.50	3.60	fisson	Fitch and Hurford, 1977
Blackstones	basalts	8 samples	58.60	0.90	K-Ar	Mitchell *et al*, 1976
Helen's reef	microgabbro	3km east Rockall	79.00	3.00	K-Ar	Harrison *et al*, 1975
	microgabbro	3km east Rockall	114.00	3.00	K-Ar	Harrison *et al*, 1975
Lundy	granite		54.80	1.40	Ar-Ar	Fitch *et al*, 1969
		dykes	56.40	0.30	Ar-Ar	Mussett *et al*, 1988
	granite		57.00	2.00	Rb-Sr	Mussett *et al*, 1988
Rockall	granite		54.00	4.00	Rb-Sr	Hawkes *et al*, 1975
	granite		54.00	4.00	Rb-Sr	Hawkes *et al*, 1975
	granite		57.00	7.00	Rb-Sr	Hawkes *et al*, 1975
St Kilda	granite	Conachair	55.00	0.50	Rb-Sr	Brook, 1984

Sample	Name	Material	J value	Sd J	Steps	WMPA	Sd	MSWD	Cum. Ar%	Iso age	Error	Sums/N-2	Intercept	Error
MT2	Muck tuff 2	sanidine	0.001952	0.25	11 of 13	60.65	0.16	2.5	81.45	60.63	0.17	2.22	248.36	83.89
MT2	Muck tuff 2	sanidine	0.00191	0.25	12 of 12	60.91	0.19	1.06	100	60.92	0.4	3.86	144.31	129.15
MT2	Muck tuff 2	sanidine	0.001956	0.3	0.9-10	60.74	0.21	0.78	100	60.56	0.24	0.64	299.54	11.13
MT2	Muck tuff 2	sanidine	0.001956	0.3	1.7-10	60.49	0.2	1.52	100	60.51	0.49	1.57	289.58	66.64
MT2	Muck tuff 2	sanidine	0.001956	0.3	1.0-10	60.58	0.25	1.33	100	60.83	0.45	3.56	264.97	62.71
MT2	Muck Tuff 2	sanidine	0.001956	0.3	2.1-10	60.61	0.21	0.29	57.94	60.55	0.26	0.44	314.33	32.42
MT2	Muck Tuff 2	sanidine	0.002653	0.3	12 of 20	60.53	0.18	3.27	79.78	60.48	0.2	3.94	291.23	101.82
MT2	Weighted Mean Age	sanidine				60.65	0.07	0.75						
MT3	Muck Tuff 3	sanidine	0.001947	0.25	13 of 14	60.51	0.16	3.35	88.22	60.47	0.18	2	240.96	59.56
MT3	Muck Tuff 3	sanidine	0.001901	0.25	11 of 11	60.42	0.16	0.86	100	60.52	0.22	0.81	194.31	81.32
MT3	Muck Tuff 3	sanidine	0.001953	0.3	3.6-10	60.36	0.19	1.54	59.41	60.34	0.3	2.24	323.61	129.45
MT3	Muck Tuff 3	sanidine	0.001953	0.3	1.6-fuse	60.2	0.19	0.91	100	59.98	0.21	2.5	318.53	23.99
MT3	Muck Tuff 3	sanidine	0.001953	0.3	1.7-4.5	60.36	0.2	1.9	100	60.44	0.24	2.76	291.21	35.5
MT3	Muck tuff 3	sanidine	0.001953	0.3	2.3-10	60.67	0.19	0.44	91.82	60.61	0.22	0.7	309.88	39.07
MT3	Muck tuff 3	sanidine	0.001953	0.3	1.7-fuse	60.52	0.19	1.02	100	60.53	0.21	1.12	309.23	46.92
MT3	Weighted Mean Age	sanidine				60.44	0.07	0.12						
EG	*Sgurr of Eigg*	*glass*	*0.000939*	*0.3*	*1.8-fuse*	*47.8*	*0.34*	*9.23*	*82.07*	*58.69*	*0.86*	*0.9*	*135.66*	*11.62*
EG	*Sgurr of Eigg*	*glass*	*0.000939*	*0.3*	*2.1-fuse*	*50.39*	*0.59*	*20.9*	*68.46*	*58.75*	*0.59*	*1.37*	*81.04*	*14.32*
EG	Weighted Mean Age	glass				47.14	0.12	87.05						
EP	Sgurr of Eigg	sanidine	0.000944	0.3	3.9-fuse	59.19	0.2	1.03	65.75	58.9	0.49	2.05	337.1	127.5
EP	Sgurr of Eigg	sanidine	0.000944	0.3	2.1-fuse	58.53	0.23	1.14	100	58.22	0.42	2.12	311.19	65.93
EP	Sgurr of Eigg	sanidine	0.000942	0.3	2.2-fuse	58.56	0.19	1.2	100	58.48	0.24	1.33	321.23	40.29
EP	Sgurr of Eigg	sanidine	0.000939	0.3	3.5-fuse	58.84	0.24	2.37	67.5	58.84	0.69	1.85	314.24	297.15
EP	Sgurr of Eigg	sanidine	0.000939	0.3	1.6-fuse	58.17	0.24	0.82	100	58.13	0.32	0.85	292.67	39.03
EP	Sgurr of Eigg	sanidine	0.000938	0.3	2.1-fuse	58.87	0.23	2.5	100	58.81	0.29	2.88	279.53	72.24
EP	Sgurr of Eigg	sanidine	0.000942	0.3	1.2-fuse	58.91	0.22	0.4	100	58.95	0.25	0.62	291.91	19.68
EP	Sgurr of Eigg	sanidine	0.000942	0.3	2.3-fuse	58.67	0.19	1.26	100	58.54	0.27	1.82	306.08	63.35
EP	Sgurr of Eigg	sanidine	0.002647	0.3	17 of 17	58.67	0.18	3.4	98.06	58.64	0.18	3.8	294.81	8.06
EP	Weighted Mean Age	sanidine				58.73	0.08	1.95						

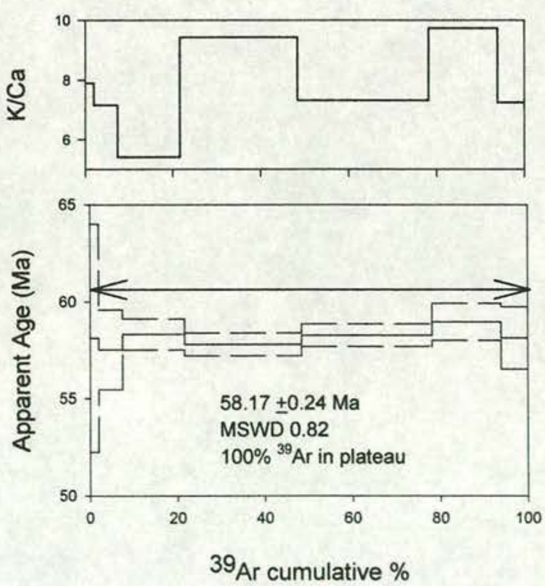
lc9f5121
Muck Tuff 2
sanidine
step-heating



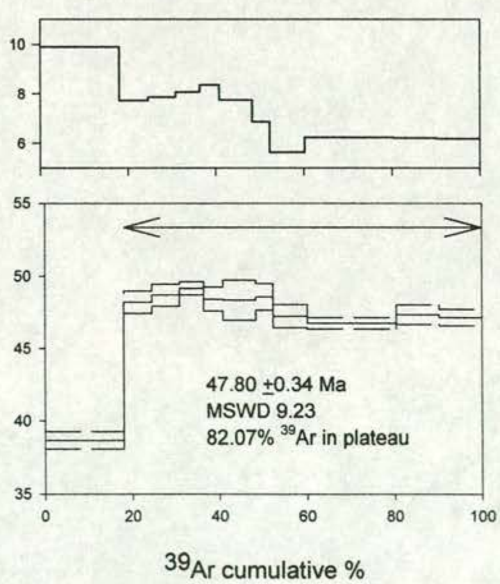
lc9f5129
Muck Tuff 3
sanidine
step-heating

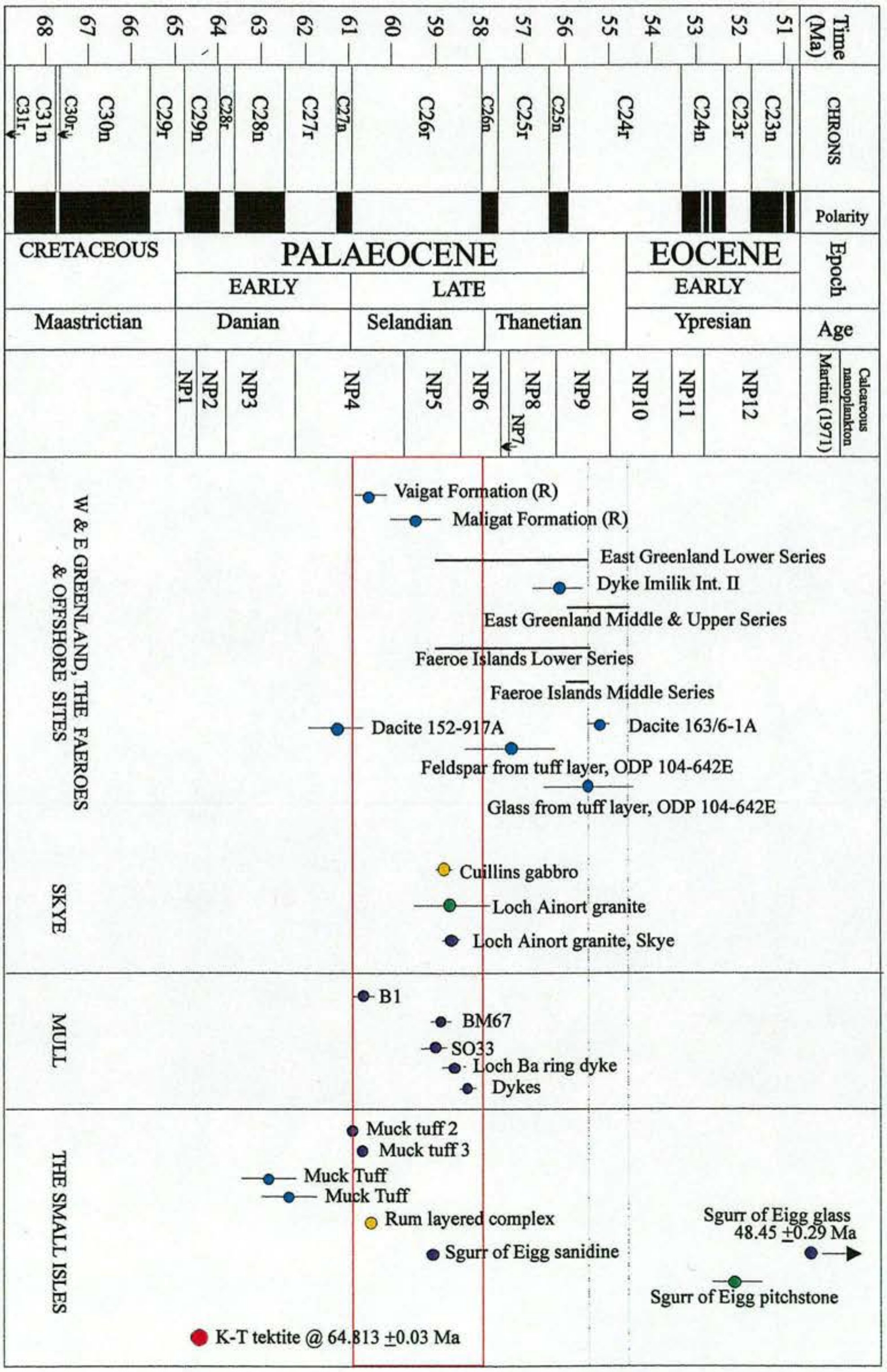


lc9f5140
Sgurr of Eigg Pitchstone
sanidine
step-heating



lc9f5066
Sgurr of Eigg Pitchstone
glass
step-heating




Time (Ma)
CHRONS
Polarity
Epoch
Age
Calcareous nanoplankton Martini (1971)
CRETACEOUS
PALAEOCENE
EOCENE
EARLY
LATE
EARLY
Maastrictian
Danian
Selandian
Thanetian
Ypresian
W & E GREENLAND, THE FAEROES & OFFSHORE SITES
Vaigat Formation (R)
Maligat Formation (R)
East Greenland Lower Series
Dyke Imilik Int. II
East Greenland Middle & Upper Series
Faeroe Islands Lower Series
Faeroe Islands Middle Series
Dacite 152-917A
Dacite 163/6-1A
Feldspar from tuff layer, ODP 104-642E
Glass from tuff layer, ODP 104-642E
SKYE
Cuillins gabbro
Loch Ainort granite
Loch Ainort granite, Skye
MULL
B1
BM67
SO33
Loch Ba ring dyke
Dykes
THE SMALL ISLES
Muck tuff 2
Muck tuff 3
Muck Tuff
Muck Tuff
Rum layered complex
Sgurr of Eigg sanidine
Sgurr of Eigg glass
48.45 ±0.29 Ma
Sgurr of Eigg pitchstone
K-T tektite @ 64.813 ±0.03 Ma

Age and duration of the Isle of Mull Tertiary igneous centre, Scotland, and the confirmation of subchrons during Anomaly 26r.

LYNNE M. CHAMBERS[1] and MALCOLM S. PRINGLE[2]

[1] *Department of Geology and Geophysics, University of Edinburgh, West Mains Road, Edinburgh, EH9 3JW, UK.*

[2] *Scottish Universities Environmental Research Centre, Rankine Avenue, Scottish Enterprise Technology Park, East Kilbride, Glasgow G75 0QF, UK.*

The duration of activity that produced the Isle of Mull Tertiary igneous centre has been constrained to 2.52 ±0.36 m.y. (1σ) using high-resolution $^{40}Ar/^{39}Ar$ radiometric-dating dating techniques. New $^{40}Ar/^{39}Ar$ ages for Mull and also one from Skye presented here, confine the duration of igneous activity to within one superchron (3 m.y. of Chron 26r). As the Mull and Skye Tertiary centres record a sequence of magnetic reversals and normals, these changes in magnetic polarity are recording tiny wiggles in the palaeomagnetic record, related to cryptochrons or fluctuations in the intensity of the magnetic direction. Recalibration of the tie points used to determine the timescale could not account for all of these changes in polarity. We propose that the new ages for the Isle of Mull Tertiary centre and also the Skye Tertiary centre indicate that these large parts of the British Tertiary volcanic province developed fast enough to record the tiny fluctuations in the geomagnetic record, accepted in the more recent parts of the geomagnetic sequence and visible in the sea-floor magnetic record.

Keywords: $^{40}Ar/^{39}Ar$, Mull, Skye, cryptochron, subchron, palaeomagnetic polarity and tiny wiggles.

Introduction

The majority of the Isle of Mull comprises one of several igneous centres formed during the Tertiary that collectively are known as the British Tertiary Igneous Province (BTIP), the most eastern manifestation of igneous activity within the wider North Atlantic Large Igneous Province. With an area of 941 km^2, Mull is one of the largest of the individual centres within the BTIP. As with the majority of the BTIP, development of the Mull Tertiary centre began with NW-SE trending fissure eruptions that produced ~2 km (Walker, 1971) of lava flows, 1000 m of which is still present today. Fissure eruptions eventually gave way to the development of a central volcano and finally the regional dyke swarm cut the whole area. Cross cutting arcuate intrusions (Bailey, 1924) within the sub-volcanic root show that the igneous activity was concentrated around three centres; C1, C2 and C3, which moved progressively north-westwards through time (Figure 1). The last intrusion within the central complex, the Loch Ba ring dyke, is cut by the NW-SE trending Mull regional dyke swarm.

Previous $^{40}Ar/^{39}Ar$ dates have placed the base of the Mull lava pile at 60 ± 0.5 (1σ) Ma and the Loch Ba ring dyke at 56.5 ± 1 (1σ) Ma (Mussett, 1986). This study provides new, higher resolution, $^{40}Ar/^{39}Ar$ ages for the stratigraphic development of the Mull lava pile and central volcano. Developments of the $^{40}Ar/^{39}Ar$ dating technique, using calibration with better known standards, have allowed the timing of igneous activity in Mull to be more tightly constrained.

Analytical Technique

Radiometric dates are obtained from $^{40}Ar/^{39}Ar$ incremental heating analysis of whole rock (250-500 μm) and felsic concentrate (106-250 μm) sieved fractions that were prepared in Edinburgh. Following petrographic examination of approximately 100 thin sections from throughout the stratigraphy in Mull, 12 were deemed suitable for $^{40}Ar/^{39}Ar$ analysis. Using samples with known magnetic polarity (SO17 and SO33, Dagley *et al.,* 1987) will allow direct correlation between the geomagnetic timescale and the radiometric ages.

The irradiation flux factor (J) was monitored approximately every 20 mm using the USGS standard Taylor Creek rhyolite sanidine 85G003 at 27.92 Ma. All errors are reported as one standard deviation of analytical precision unless otherwise stated. A more detailed description of the $^{40}Ar/^{39}Ar$ analytical procedure can be found in Singer *et al.* (1999) and Hardarson *et al.* (1997) and details of the irradiation conditions can be found in Chambers (2000).

Results

The reliability of each $^{40}Ar/^{39}Ar$ date is assessed using the criteria of Pringle (1993) and Singer and Pringle (1996). Data from the incremental-heating experiments are presented in Table 1 and the complete analysis of each sample can be found in the appendix. Age spectra diagrams for all of the incremental-heating experiments, which fulfilled the aforementioned criteria, can be seen in Figure 2.

Of the twelve Mull samples analysed, eight met all of the criteria. Of those eight, sample B1 preserves McCulloch's tree at the base of the plateau lava succession in the west of the island. B1 reached an incremental-heating crystallisation age of 60.56 ± 0.3 Ma., which coincides with the 60.5 ± 0.5 Ma. weighted mean age of Mussett (1986) for the base of the lava succession. BM64 and BM67 (3 flows above BM64) are lavas sampled by Kerr (1993) from the Ben More sequence. These lavas are the highest (at approximately 700m above sea level) in the lava succession that were analysed. Both yield concordant apparent plateau ages, which are within error of each other. The best age estimate of these BM samples is a weighted mean age of both experiments at 58.38 ±0.19 Ma.

Plateau lava eruption eventually was superseded by the development of a central volcano. Samples SO33 and SO17 are lavas from within the first of the three central volcanoes. These samples have normal magnetic polarity (Dagley *et al.*, 1987). SO33 reached an apparent age plateau at 58.94 ±0.3 Ma., whereas SO17 contained slight excess argon so the isochron age of 59.66 ±0.64 Ma. is the best estimate of the crystallisation age of this sample. The combined weighted mean age of 59.05 ±0.27 Ma. is used as the age of the SO or centre 1 samples. This weighted mean age is older than that for the BM samples, which occur earlier in the magmatic succession. Analysis by $\delta^{18}O$ shows that the BM samples are highly altered by hydrothermal fluids (Chambers, 2000) with low $\delta^{18}O$ values. The age for the BM samples should be treated with caution as it possibly represents the age of a later hydrothermal event.

The SO weighted mean age is further re-enforced by ages for the younger Loch Ba ring dyke and the crosscutting dykes. Sample LB1 is a sanidine concentrate from the Loch Ba ring dyke, which was the last igneous event within the central volcano (C3). It gave an age of 58.48 ± 0.1 Ma. The cross cutting dykes of MD1-MD3 give similar ages of 58.0 Ma. MD1 and MD3 are the same rock; MD1 was the whole rock and MD3 a felsic concentrate. A weighted mean age using all three dyke sample ages at 58.12 ±0.13 Ma. Provides the best age for the crosscutting dykes.

Correlation of the magnetic history to the time scale

Detailed palaeomagnetic studies of the Mull volcano have been carried out by Dagley *et al.* (1987), Ade-Hall (1974) and Mussett *et al.* (1980). Mussett *et al.* (1980) conclude that Mull had a palaeomagnetic sequence of Reversed-Normal-Reversed (R-N-R), assuming overprinting. They suggested that the central group lavas were normally polarised by overprinting of a later event or by slow cooling which produced an apparent sequence of R-N-R-N-R rather than R-N-R. Later palaeomagnetic work by Dagley *et al.* (1987), which sampled the central complex in more detail, showed that there was a minimum of 7 reversals. However, available $^{40}Ar/^{39}Ar$ ages confined the number of reversals and normals to only 3 (R-N-R sequence) corresponding to Chrons 26r, 26n and 25r. Overprinting was therefore required to cause the other apparent reversals and normals. If no overprinting is assumed then there is a minimum of 7 reversals and normals recorded in the Mull centre (Dagley *et al.*, 1987). Using the new $^{40}Ar/^{39}Ar$ ages presented here (Table 1) to constrain the timing of the Mull volcano and the palaeomagnetic results of Dagley *et al.* (1987), all seven short reversals and normals fall within one long magnetic reversal, 26r (using the timescale of Berggren *et al.*, 1995). The samples SO33 and LB1 that have normal magnetic polarity both now have ages that plot well within 26r. Whether the rocks of Mull have been overprinted or not, the new dates show that the whole of the sequence occurred within one superchron, 26r (60.92-57.91 Ma, Berggren *et al.*, 1995). Overprinting is no longer required to explain the extra reversals and normals found by Dagley *et al.* (1987), especially where the samples do not show a secondary magnetic component. In addition to Mull, the Tertiary centre of Skye also records a pattern of reversals and normals (Dagley *et al.*, 1990), however because the existing Ar-Ar ages from Skye (Dagley *et al.*, 1990) had large associated errors, these reversals in magnetic polarity were believed to be real and not due to overprinting.

Models that account for normal polarity events within Chron 26r

Three models that seek to account for normal polarity events within Chron 26r are presented here and discussed in turn.

The first model assumes that the normal polarity events are the result of later overprinting. A detailed look at the palaeomagnetic data and the cross cutting relationships in Mull reveals an apparently complicated magnetic history. Firstly, there are 1000m plateau lava flows that can be traced from the west coast to the top of Ben More, all of which have reversed polarity. These plateau lavas are cut by Centre 1 (C1) of the central complex. Within C1 are lava flows and pillow lavas that formed during an eruption into a caldera lake. Inside the main ring fault of the caldera these lavas have normal magnetic polarity and outside the ring fault they have reversed magnetic polarity. The lavas within the central complex that possess N polarity show no evidence for a secondary component during demagnetisation (Dagley *et al.*, 1987). Correlation across the ring fault is difficult, so that these lavas with different polarity could be of a slightly different age. Samples SO33 and SO17 are lavas flow from inside the ring fault and have normal magnetic polarity, whereas the remaining intrusions of C1 have R polarity, including the early acid and basic cone sheets. These suites of cone sheets can be shown in the field to cut the lavas inside the caldera (N polarity) (Emeleus and Gyopari, 1992). This places the timing of these Normal polarity pillow lavas in-between the plateau lavas (R) and the intrusions of C1 (R). The intrusion of acid cone sheets (N polarity) and later cone sheets cutting C1 (R, N and intermediate polarity) mark the beginning of C2. The remainder of C2 has N polarity, as does the whole of Centre 3, including the Loch Ba ring dyke. The last igneous event on Mull, the cross cutting dykes, have R polarity. This gives a total of seven changes of polarity recorded in the Mull succession (Dagley *et al.*, 1987).

The preservation of cross cutting relationships with rocks of different magnetic polarity implies that no major widespread overprinting has occurred. Most samples show no significant amount of secondary magnetic polarity, but a secondary magnetisation component can be seen and removed from the Glen More ring dyke to give the primary magnetisation direction (Dagley *et al.*, 1987). This also suggests that complete overprinting has not occurred within the central complex.

The second and third models involve the existence of smaller magnetic events within a larger Chron. Cande and Kent (1992a) found distinctive and coherent patterns of tiny wiggles in the sea-floor magnetic patterns during Chron 26r, which were superimposed onto the long reversals (superchrons) (Figure 3). These patterns are also visible on fast spreading ridges in the Indian Ocean and the South

East Pacific. These patterns of tiny wiggles, or cryptochrons, can be attributed to slight fluctuations in the intensity of the geomagnetic field (Cande and LaBrecque, 1974), or short polarity intervals (Blakely, 1974). Cryptochrons, as defined by Cande and Kent (1992a), are modelled magnetic anomalies that are less than 30 kyr in duration, in a calibrated timescale, and are reversals that occur with a wavelength of 8-25 Km and an amplitude of 25-100 nT. In their revised timescale, Cande and Kent (1992b) propose the existence of 7 cryptochrons in Chron 26r (see Figure 3). Cryptochrons are only used in the timescale when they are converted to subchrons based on stratigraphy. Cande and Kent (1992b) modelled the wiggles seen in 26r and proposed that they were due to variations in paleointensity and not true reversals.

Normal polarity events seen in Mull could be evidence that true small reversals in polarity can be seen within Chron 26r. If all of these changes in polarity are cryptochrons, it is likely (as they are only 30 kyr in duration) that there is a R polarity period between C2 and C3, making nine changes in magnetic polarity, as is shown in Model one in Figure 4. The detailed magmatic history and cross cutting relationships provide a control that exists on Mull, which is of fundamental importance in determining the existence of cryptochrons.

Model three also uses an alternative possibility for the lack of correlation between the palaeomagnetic history and the $^{40}Ar/^{39}Ar$ ages that should be considered and relates to the way that the geomagnetic timescale is produced. Tie-points in the timescale are fixed using $^{40}Ar/^{39}Ar$ ages or biostratigraphic evidence. The thickness of the magnetic stripes are measured between two tie points and the duration of the reversals and normals are calculated using constant sea-floor spreading rates. The time scales of Cande and Kent (1995) and Berggren *et al.* (1995) use nine tie points to calibrate the seafloor spreading curve during the Cenozoic. In Berggren *et al.* (1995) and Cande and Kent (1995) the tie points relevant to the position of Chron 26r are the Cretaceous-Tertiary (K-T) boundary

(65 Ma) and the Palaeocene-Eocene boundary (55 Ma). The K-T boundary is constrained by a weighted mean Ar-Ar age of 64.6 Ma (Swisher *et al.*, 1992 & 1995) and 65.44 ±0.07 Ma from Dalrymple *et al.*, (1993). The Palaeocene – Eocene boundary is less well constrained and is based on and age of the –17 ash layer within the Mo clay sequence, Denmark. The weighted mean age of 55.07 ±0.16 published in Berggren *et al.* (1992) but obtained by J.D. Obradovich, and ages from Swisher and Knox (1991, unpublished data) for the British equivalents of the –17 ash at 54.51 ±0.05 Ma. and 54.56 ±0.14 Ma. are used. The –17 ash is also present in DSDP well 550 where it lies 7m above the NP9/NP10 calcareous nanofossil zonal boundary (Berggren *et al.*, 1995). An age of 55 Ma for this zonal boundary was estimated by Swisher and Knox (1991) and was first used by Cande and Kent (1992) for the Palaeocene-Eocene boundary. Recent work on DSDP Hole 550 by Ali and Hailwood (1998) suggests that the original magnetic stratigraphy for this hole was in error and the position of the base of Chron 24n in the geomagnetic timescale should be older than its present position. If the position of the Palaeocene–Eocene tie point is adjusted, when more reliable ages are available, then it would need to be at least 0.5 Ma older than its present position to correspond to the youngest age for an intrusion with normal polarity in Mull. However, all of the intrusions in Centre 3 have normal magnetisation, and the LB1 age is for the last of these intrusions. The sequence of seven or even nine stratigraphically controlled reversals and normals recorded in Mull cannot be explained by only making Chron 26n older. This does not mean that the last normal polarity events recorded in Centres 2 and 3, or even just Centre 3, could not be Chron 26n. Cross cutting relationships mean that adjusting the positions of the Chrons cannot account for all of the changes in magnetic polarity and at the existence of at least two cryptochrons is needed to explain all of the events.

Discussion

The $^{40}Ar/^{39}Ar$ ages presented here were are relative to the USGS standard Taylor

Creek rhyolite sanidine 85G003 at 27.92 Ma which is equivalent to Fish Canyon tuff sanidine at 27.62 ±0.02 Ma. These standard values give an age of 64.81 ±0.03 Ma for K-T tektite measured at SUERC during the course of this study. This age is in line with the 65 Ma used in both Cande and Kent (1995) and Berggren *et al.* (1995) for the K-T tie point. Unlike changing the position of the Palaeocene–Eocene boundary, if the K-T tie point is moved then all of our ages would have to be adjusted in response. As the $^{40}Ar/^{39}Ar$ technique relies on the ages of standards used, Renne *et al.* (1998) have published a list of suggested standard values. The sanidine standards used in this study correspond to an age of 514.0 ±1.1 Ma (Pringle, 1993) for the McClure Mountain hornblende (MMhb-1) not the 523.1 Ma suggested by Renne *et al.* (1998). If the Renne *et al.* (1998) value is used then the SUERC K-T tektite age would change to 66.13 Ma, which does not then correspond to the 65 Ma used in the time scale. Changing the ages of the standards used in this study in line with Renne *et al.* (1998) would make all of the ages older including the K-T tektite, but would not account for the presence of normal polarity events within Chron 26r.

Recent work by Singer *et al.* (1999) uses the $^{40}Ar/^{39}Ar$ dating technique to separate magnetic reversals in the more recent parts of the timescale. By directly analysing the rocks thought to bracket the transitions between reversal events many previously joined events have been separated into different reversals. For example, three new ages from the Punaruu Valley, Tahiti thought to show the Cobb Mountain Normal Polarity Subchron show that they were, in fact, erupted about 76 k.y. after the Cobb Mountain event and so therefore show another new transition. They concluded that short-lived polarity events during the Matuyama reversed Chron show that there were no fewer than seven, and maybe more than eleven, attempts of the geodynamo to reverse between 1.18 and 0.78 Ma. If the geodynamo frequently tried to reverse in the more recent parts of the timescale, then the 3 m.y. duration of Anomaly 26r could indeed be subdivided by subchrons. There is no apparent reason to suppose that the frequent reversals are only confined to the recent part of the timescale. Indeed, many superchrons contain subchrons throughout the geomagnetic sequence.

Summary

The models presented here can be used to explain the palaeomagnetic sequences seen in Mull and Skye and their lack of correlation to the present geomagnetic timescale, two of these models are shown in Figure 4. A third model assumes that the normal polarity events recorded in the rocks of Mull and Skye are overprinted. However, we do not consider this to be the case as the samples showed no secondary component of magnetisation and, if the normal polarity period was later overprinting, this implies that whole centres would have to be remagnetised and not selective suites of igneous intrusions. The remaining two models are shown in Figure 4 where Model 1 shows all of the normal polarity events as cryptochrons with the timescale unchanged, and Model 2 where normal polarity events of Centres 2 and 3 are correlated to Chron 26n in an older position. This model is considered to be more likely due to the numbers of large intrusions that comprise Centres 2 and 3. It is unlikely that this succession of intrusions would have formed in the short duration of cryptochrons. Model 2 does show that even if Centres 2 and 3 of Mull are recording Chron 26n then the existence of two cryptochrons is needed to explain the earlier normal polarity events.

In addition to Mull, the Tertiary sequence of Skye also records a series of reversals in magnetic polarity. Dagley *et al.* (1990) found a total of nine reversals in Skye (Figure 4). Individual biotite crystals from the Loch Ainort granite were analysed by laser incremental-heating using a CO_2 laser as part of this study. A weighted mean age of 58.58 ±0.13 Ma is based on a total of 4 incremental-heating experiments. As Figure 4 shows, this age means that the majority of the Skye Tertiary centre was also formed during Chron 26r. It is interesting to note that in Model 2 (Figure 4) the Loch Ainort granite corresponds to a reversed cryptochron within Chron 26n, visible in some of the seafloor spreading records in Cande and Kent (1992a) shown in Figure 3. It may also explain why this short reversal is not seen in the Isle of Mull. As these new ages show, the rocks of Skye and Mull can be correlated using new Ar-Ar ages and palaeomagnetic sequences.

Conclusions

Using 1σ errors on the $^{40}Ar/^{39}Ar$ ages, the total time taken for the plateau lavas and the Mull Tertiary centre to form is 2.52 ±0.36 m.y. The measured palaeomagnetic sequence of R-N-R, if overprinting is assumed, when used in conjunction with the new ages shows that the whole igneous sequence in Mull formed within 26r (Berggren *et al.*, 1995). As overprinting is no longer required to explain the nine possible reversals and normals on Mull then these all occurred during Chron 26r. Intercalibration of these ages to suggested values in Renne *et al.*, (1998) does not change this, since it makes all of the ages older and further within 26r. The results from the K-T tektite show that our age of 64.81 ±0.03 Ma is directly comparable with the 65 Ma used in the geomagnetic time scale. Even if Chron 26n is made older through the more accurate calibration of the Palaeocene – Eocene boundary it cannot explain the complex stratigraphically controlled palaeomagnetic sequence on Mull.

The new age of 58.58 ±0.13 Ma. for the Loch Ainort granite, Skye, also shows that the bulk of igneous activity forming this Tertiary centre occurred during 26r. The sequence of nine polarity reversals on Skye can be directly correlated to those on Mull.

Rapid eruption and formation of Mull and Skye was fast enough to record cryptochrons during 26r that are visible in the sea-floor spreading record. Due to the discovery that during the more recent parts of the timescale the geodynamo attempted to reverse at least seven times in 0.5 m.y. (Singer *et al.*, 1999) we propose that the sequence of lavas and intrusions on the Isle of Mull and the Isle of Skye preserve such attempts during the 3 m.y. of Anomaly 26r.

Biostratigraphic data (Bell and Jolley, 1997) suggests that the age of the Mull plateau lavas is 55 Ma. and the lava sequence of Isle of Skye is 58 Ma. This does not agree with the $^{40}Ar/^{39}Ar$ ages and the magnetic history and so suggests that the biostratigraphic age is somehow in error.

The work was carried out as part of a NERC funded PhD project and was supported by NERC Grant GT4/96/87/E. Samples were kindly provided by Peter Dagley (SO33 and SO17) and Andrew Kerr (BM67 and BM64). Godfrey Fitton is thanked for helpful discussion and Lee Newcombe for assistance in the field.

References

Ade-Hall, J. M. 1974. The palaeomagnetism of some basic dykes cutting the Loch Ba ring dyke, Isle of Mull, Scotland. *Geophys. J. R. Astr. Soc,* **36,** 267-271.

Ali, J. R. and Hailwood, E. A. 1998. Magnetostratigraphic (re)calibration of the Paleocene/Eocene boundary interval in holes 550 and 549, Gobun Spur, eastern North Atlantic. Earth and Planetary Science Letters 161, 201-213.

Bailey, E. B., Clough, C.T., Wright, W.B., Richey, J. E., Wilson, G. V. 1924. Tertiary and Pre-Tertiary geology of Mull, Loch Aline and Oban. *Memoirs of the Geological Survey of Scotland.*

Bell, B. R. & Jolley, D. W. 1997. Application of palynological data to the chronology of the Palaeogene lava fields of the British Province: implications for magmatic stratigraphy. *Journal of the Geological Society, London,* **154,** 701-708.

Berggren, W.A., Kent, D. V., Swisher, C.C. & Aubry, M-P. 1995. A revised Cenozoic geochronology and chronostratigraphy. *In: Geochronology, time scales and global stratigraphic correlation,* Society for Sedimentary Geology Special

Publication, **54,** 129-212.

Berggren, W. A., Kent, D. V., Obradovich, J. D and Swisher, C.C. 1992. Towards a revised Paleogene geochronology. In: Prothero, D. R. and Berggren, W. A. (eds) Eocene-Oligocene climatic and biotic evolution. Princeton, Princeton University Press, 29-45.

Blakely, R. J. 1974. Geomagnetic reversals and crustal spreading rates during the Miocene. *Journal of Geophysics Research*, **70,** 2979-2985.

Cande, S. C. & Kent, D. V. 1992a. Ultrahigh resolution marine magnetic anomaly profiles: a record of continuous paleointensity variations? *Journal of Geophysical Research,* **97,** 15,075-15,083.

Cande, S. C. & Kent, D. V. 1992b. A new geomagnetic polarity time scale for the Late Cretaceous and Cenozoic. *Journal of Geophysical Research,* **97,** 13,917-13,951.

Cande, S. C. & Kent, D. V. 1995. Revised calibration of the geomagnetic polarity timescale for the Late Cretaceous and Cenozoic. *Journal of Geophysical Research,* **100,** 6093-6095.

Cande, S. C. & LaBrecque, J. L. 1974. Behaviour of the Earth's palaeomagnetic field from small scale marine magnetic anomalies. *Nature*, **247**, 26-28.

Chambers, L. M. 2000. Age and duration of the British Tertiary Igneous Province: implications for the development of the ancestral Iceland plume. Unpublished PhD thesis, University of Edinburgh.

Dagley, P., Mussett, A. E. & Skelhorn, R. R. 1987. Polarity, stratigraphy and duration of the Tertiary igneous activity of Mull, Scotland. *Journal of the Geological Society, London,* **144,** 985-996.

Dagley, P., Mussett, A. E. & Skelhorn, R. R. 1990. Magnetic polarity stratigraphy of the Tertiary igneous rocks of Skye, Scotland. *Geophysical Journal International,* **101**, 395-409.

Dalrymple, G. B., Izett, G. A., Snee, L.W. and Obradovich, J. D. 1993. $^{40}Ar/^{39}Ar$ age spectra and total-fusion ages of tektites from Cretaceous-Tertiary boundary sedimentary rocks in the Beloc Formation, Haiti. United States Bulletin, 2065, 1-

20.

Emeleus, H. and Gyopari. 1992. The British Tertiary Volcanic Province. Chapman and Hall.

Kerr, A. C. 1993. The geochemistry and petrogenesis of the Mull and Morvern Tertiary lava succession, Argyll, Scotland. Unpublished PhD thesis. University of Durham.

Mussett, A. E., Dagley, P & Skelhorn, R.R. 1980. Magnetostratigraphy of the Tertiary igneous succession of Mull, Scotland. *Journal of the Geological Society, London,* **137,** 349-357.

Mussett, A. E. 1986. ^{40}Ar-^{39}Ar step-heating ages of the Tertiary igneous rocks of Mull, Scotland. *Journal of the Geological Society, London,* **143,** 887-896.

Pringle, M. P. 1992. Radiometric ages of basaltic basement recovered at sites 800,801 and 802, leg 129, western Pacific Ocean. *Proceedings of the Ocean Drilling program, scientific results,* **129.**

Pringle, M. S. 1993. Age progressive volcanism in the Musicians seamounts: a test of the hot spot hypothesis for the late Cretaceous Pacific. *In:* Pringle, M. S., Sager, W. W., Sliter, W. V. & Stein, S. (Ed.) *The Mesozoic Pacific geology, tectonics and volcanism.* Am. Geophys. Union. Geophys. Monogr, **77,** 187-215.

Singer, B. S., Hoffman, K. A., Chauvin, A., Coe, R. S., and Pringle, M. P. 1999. Dating transitionally magnetised lavas of the Matuyama Chron: Toward a new ^{40}Ar-^{39}Ar timescale of reversals and events. *Journal of Geophysics Research, solid Earth, 104, 679-693.*

Singer, B. S & Pringle, M. S. 1996. Age and duration of the Matuyama-Brunhes geomagnetic polarity reversal from $^{40}Ar/^{39}Ar$ incremental heating analysis of lavas. *Earth and Planetary Science Letters,* **139,** 47-61.

Swisher C. C., Dingus, L., Montanari, A. and Smit, J. 1995. Terminal Cretaceous events in classic marine and terrestrial sections synchronous with the Chicxulub impact. Geophysical research letters.

Swisher, C.C., Dingus, and Butler, R. F. 1993. $^{40}Ar/^{39}Ar$ dating and magnetostratigraphic correlation of the terrestrial Cretaceous-Paleogene boundary and Puercan mammal age, Hell Creek-Tullock formations, eastern Montana. Canadian journal of Earth Sciences, 30, 1981-1996.

Swisher, C.C. and Knox R. O'B. 1991. The age of the Paleocene/Eocene boundary: $^{40}Ar/^{39}Ar$ dating of the lower part of NP10, North Sea Basin and Denmark. Abstract :ICCP 308 (Paleocene/Eocene boundary events). International Annual Meeting and field conference, 2-6 December 1991, Brussels, Abstracts with program, 16.

Renne, P. R., Swisher, C.C., Deino, A.L., Karner, D.B., Owens, T. L. and DePaolo, D. J. 1998. Intercalibration of standards, absolute ages and uncertainties in ^{40}Ar-^{39}Ar dating. *Chemical Geology*, **145,** 117-152.

Walker, G. P. L. 1971. The distribution of amygdale minerals in Mull and Morvern (western Scotland). *In:* Murty, T. V. V. G. G. R. K. & Rao, S. S. (ed) *Studies in Earth Sciences,* W. D. West Commemorative Volume, 181-194.

Figure Captions

Figure One. A simplified geological map of the Isle of Mull showing the location of the sample sites and the position of the three centres of igneous activity moving northwestwards with time.

Figure Two. Age spectra for the eight samples that met all of the stratigraphic and statistical criteria of Pringle (1993) and Singer and Pringle (1996). K/Ca is also shown for each experiment. The arrows mark the steps that were used in the plateau age calculation. The error bars shown for each plateau mark the age $\pm 2\sigma$.

Figure Three. Seafloor magnetic records redrawn from Cande and Kent (1992a). Records from three spreading centres have been stretched to the same length. The location of the seven cryptochrons are marked with dots and labelled using the scheme of Cande and Kent (1995). The faster spreading centre shows better resolution of the tiny wiggles within Chron 26r. A small wiggle can be seen within Chron 26n, which may correspond to the Loch Ainort granite, Skye.

Figure Four. Two models showing the possible correlation between the magnetic histories of Skye and Mull with the geomagnetic timescale. Normal polarity events are shown in black and cryptochrons from Cande and Kent (1995) are shown as dashed lines. The stratigraphy in Skye and Mull is taken from Emeleus and Gyopari (1992) and the palaeomagnetic sequences from Dagley *et al.* (1990 and 1987). Model 1 shows the timescale drawn to scale with the normal polarity events seen in Mull and Skye correlated to individual cryptochrons within 26r. Model two shows the later events of Centres 2 and 3 in Mull and the corresponding sequence in the Redhills of Skye correlated to Chron 26n. It does not however account for all of the normal polarity events seen in these two areas. In Model two, the reversed Loch Ainort granite becomes a reversed cryptochron in Chron 26n. The U/Pb age for the Cuillins is from Hamilton *et al.* (1996) and all other ages are Ar-Ar ages presented here.

Table One. A summary of the results from all of the rocks dated in this study from the Isle of Mull and the Isle of Skye. Complete analyses can be found in the appendix. Those experiments shown in Italics failed the rigorous statistical criteria of Singer and Pringle (1996) and Pringle (1993). All ages are given relative to the USGS Taylor Creek Rhyolite sanidine 85G003 at 27.92 isochron.

Figure 1

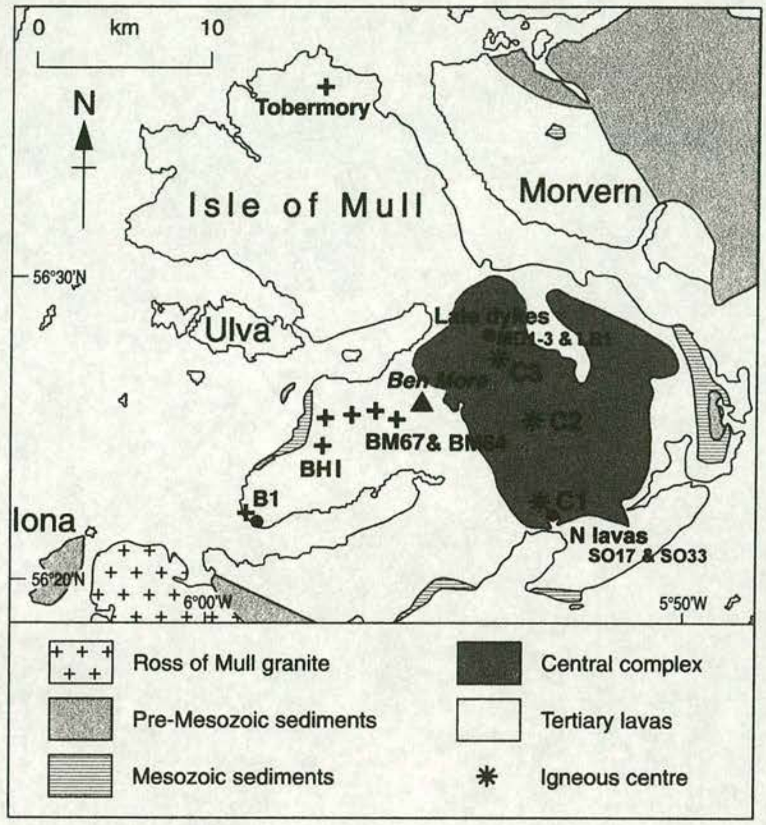
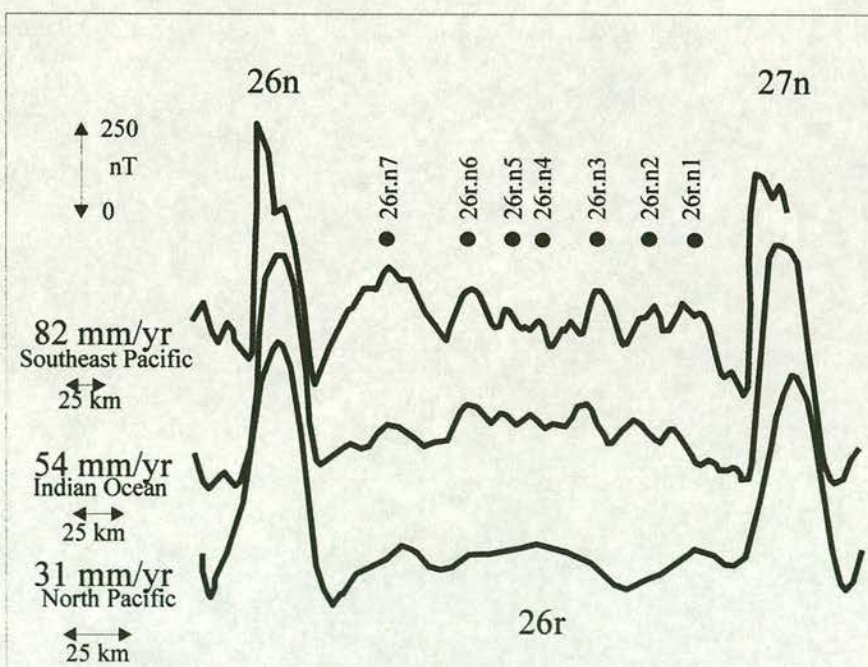


Figure 3



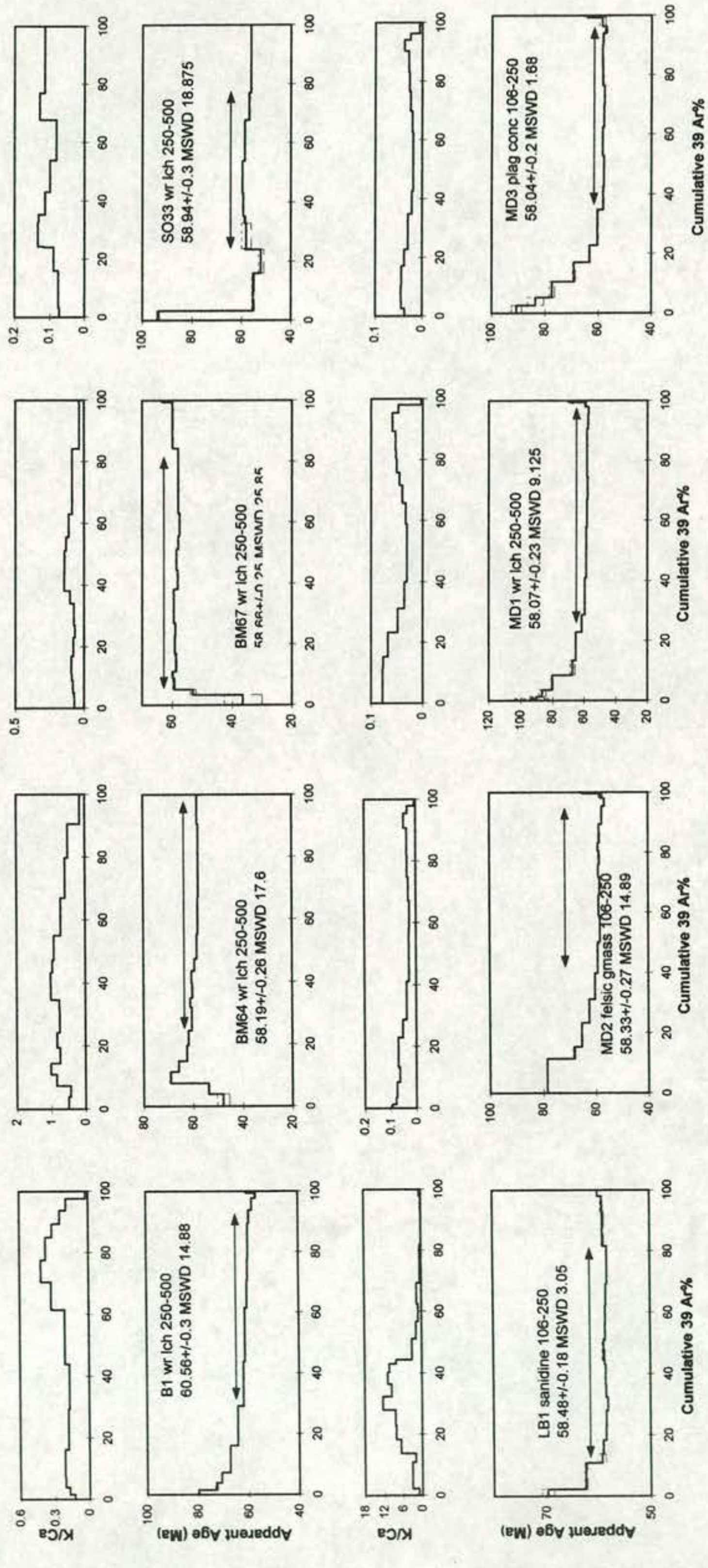
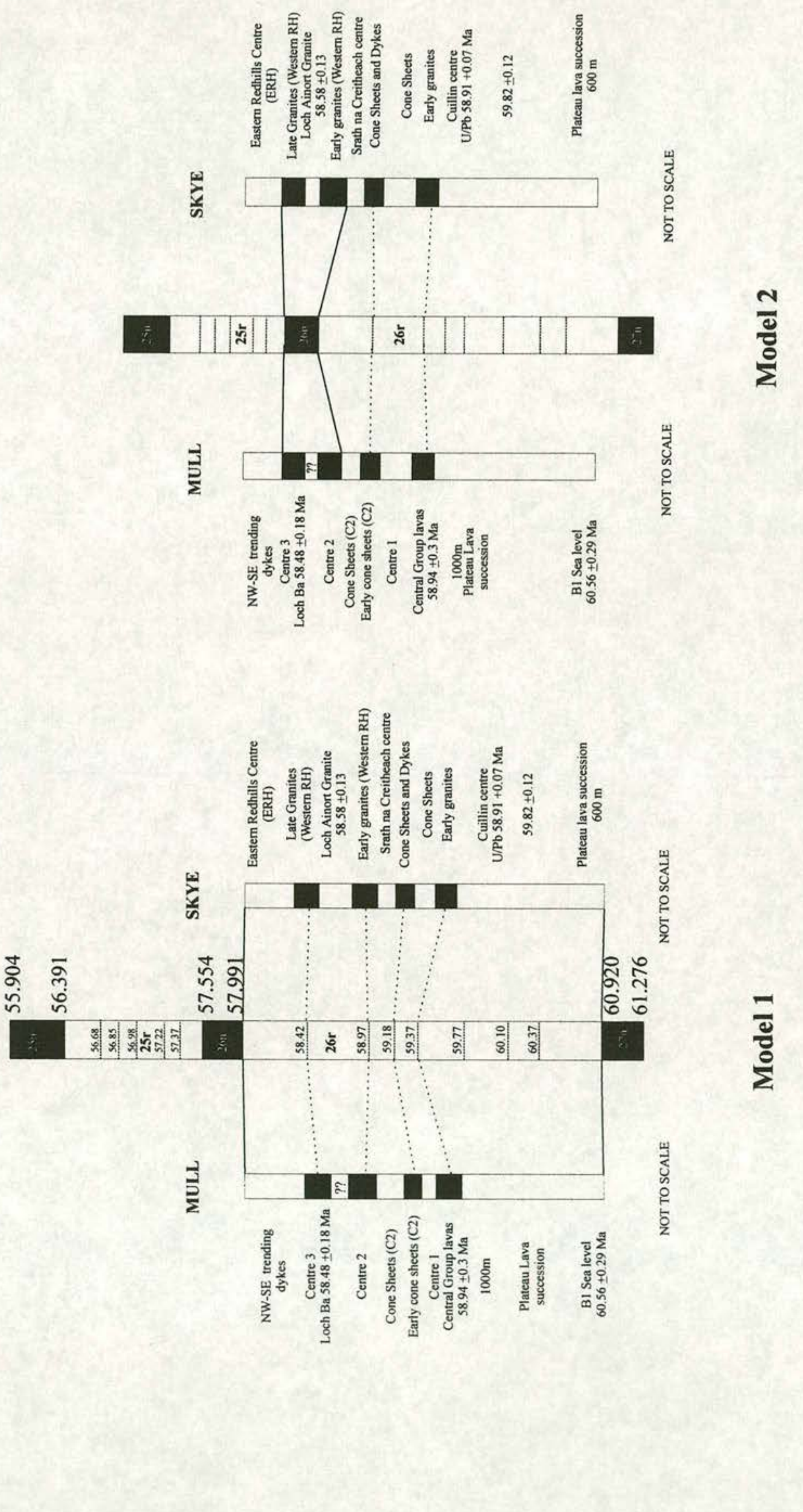

K/Ca
Apparent Age (Ma)
Cumulative 39 Ar%
B1 wr lch 250-500
60.56+/-0.3 MSWD 14.88
BM64 wr lch 250-500
58.19+/-0.26 MSWD 17.6
BM67 wr lch 250-500
SO33 wr lch 250-500
58.94+/-0.3 MSWD 18.875
LB1 sanidine 106-250
58.48+/-0.18 MSWD 3.05
MD2 felsic gmass 106-250
58.33+/-0.27 MSWD 14.89
MD1 wr lch 250-500
58.07+/-0.23 MSWD 9.125
MD3 plag conc 106-250
58.04+/-0.2 MSWD 1.68

Figure 2



Model 1
MULL
SKYE
NOT TO SCALE
NW-SE trending dykes
Centre 3
Loch Ba 58.48 ±0.18 Ma
Centre 2
Cone Sheets (C2)
Early cone sheets (C2)
Centre 1
Central Group lavas 58.94 ±0.3 Ma
1000m
Plateau Lava succession
B1 Sea level 60.56 ±0.29 Ma
55.904
56.391
56.68
56.85
56.98
25r
57.22
57.37
57.554
57.991
58.42
26r
58.97
59.18
59.37
59.77
60.10
60.37
60.920
61.276
Eastern Redhills Centre (ERH)
Late Granites (Western RH)
Loch Ainort Granite 58.58 ±0.13
Early granites (Western RH)
Strath na Creitheach centre
Cone Sheets and Dykes
Cone Sheets
Early granites
Cuillin centre U/Pb 58.91 +0.07 Ma
59.82 ±0.12
Plateau lava succession 600 m
Model 2
MULL
SKYE
NOT TO SCALE
NW-SE trending dykes
Centre 3
Loch Ba 58.48 ±0.18 Ma
Centre 2
Cone Sheets (C2)
Early cone sheets (C2)
Centre 1
Central Group lavas 58.94 ±0.3 Ma
1000m Plateau Lava succession
B1 Sea level 60.56 ±0.29 Ma
25r
26r
Eastern Redhills Centre (ERH)
Late Granites (Western RH)
Loch Ainort Granite 58.58 ±0.13
Early granites (Western RH)
Strath na Creitheach centre
Cone Sheets and Dykes
Cone Sheets
Early granites
Cuillin centre U/Pb 58.91 +0.07 Ma
59.82 ±0.12
Plateau lava succession 600 m

Figure 4

Sample	No.	K/Ca (total)	Age Plateau summary					Isochron Summary				
			39Ar (%)	No. of steps	Age (Ma)	+/- 1 sd	MSWD	Age (Ma)	+/- 1 sd	Sums N-2	40Ar/36Ar intecept	+/- 1sd
B1	44	0.248715	60.09	24.0-31.0	60.56	0.29	14.88	60.3	0.429	11.37	284.6	132.95
BB6	*47*	*0.040480*	*42.86*	*17.0-20.5*	*62.26*	*0.4295*	*33.875*	*58.88*	*0.698*	*0.626*	*550.56*	*40.22*
T3	*45*	*0.048128*	*42.85*	*24.0-32.0*	*60.59*	*0.195*	*0.922*	*57.095*	*3.3*	*0.68*	*400.699*	*82.6*
BM64	66	0.616418	60.47	23.5-43.0	58.19	0.263	17.6	58.08	0.364	14.31	307.8	18.04
BM67	42	0.078309	80.895	17.0-37.0	58.66	0.25	25.85	58.18	0.34	20.77	309.95	9.14
BM	**WM**				**58.38**	**0.19**	**1.45**					
SO33	43	0.086772	51.69	19.5-32.0	58.94	0.299	18.875	57.95	1.179	26.27	321.96	33.81
SO17	*120*	*0.010491*	*55.93*	*17.0-32.0*	*61.54*	*0.24*	*2.02*	*59.66*	*0.64*	*1.28*	*315.5*	*6.22*
SO	***WM***				***59.05***	***0.27***	***1.13***					
LB1	65	0.000491	55.54	18.0-33.0	58.48	0.18	3.05	58.45	0.287	3.898	298.49	30.12
LB2	64	5.171196	66.898	19.0-43.0	56.6	0.208	5.72	56.57	0.233	6.92	298.77	3.65
MD1	118	0.037443	66.77	21.0-33.0	58.07	0.23	9.125	58.53	0.4	10.24	285.58	7.2
MD2	119	0.044519	58.11	19.0-37.0	58.33	0.266	14.89	58.4	0.32	19.23	293.48	2.89
MD3	117	0.026004	73.46	19.0-37.0	58.04	0.197	1.681	58.09	0.334	2.12	294.2	4.84
DYKES (MD)	**WM**				**58.12**	**0.13**	**0.42**					
SG16	5107	62.3	53.52	2.8-4%	58.4	0.21	0.86	58.19	0.51	0.79	311.67	28.87
SG16	5110	56.9	56.71	2.1-10%	59.22	0.29	0.63	59.95	0.72	0.56	278.72	11.13
SG16	5091	9	84.9	1.8-10%	64.42	0.53	3.37	64.23	1.26	5.57	297.06	15.56
SG16	5113	36.1	84.24	1.5-10%	65.14	0.85	6.26	66.12	1.89	11.17	281.77	18.69
SG16	**WM**				**58.58**	**0.13**	**2.04**					

Table 1

Appendix B

B1 $^{40}Ar/^{39}Ar$ results

B2 $^{40}Ar/^{39}Ar$ sample lists

Results table for the Small Isles

Step (a)	40Ar/39Ar (b)	37Ar/39Ar (b)	36Ar/39Ar (b)	40Ar s.d. (%)	39Ar s.d. (%)	37Ar s.d. (%)	36Ar s.d. (%)	40ArR (mol)	40ArR (c)	40ArK (c)	39ArCa (c)	36ArCa (c)	K/Ca (%)	39Ar (%)	Apparent Age (Ma)	+-	1 s.d. (Ma)
MT3		Sanidine		J =	0.00195	+-	4.9E-06	(1 s.d.)		Exp. No.: 3I0027.IHD		Total gas age =			60.39	+-	0.16
tf1	17.567	0.03453	0.000257	0.07	0.07	39.96	39.34	2.40E-13	99.6	0	0	3.54	14.19	3.9	60.42	+-	0.12
tf3	17.644	0.017116	0.00016	0.06	0.08	50.11	41.78	4.00E-13	99.7	0	0	2.82	28.63	6.3	60.77	+-	0.09
tf4	17.669	0.02438	0.000183	0.06	0.09	40.33	39.76	3.50E-13	99.7	0	0	3.52	20.1	5.5	60.84	+-	0.1
tf5	17.815	0.009665	0.000968	0.08	0.09	170.98	11.34	2.10E-13	98.4	0	0	0.26	50.7	3.3	60.54	+-	0.13
tf6*	17.624	0.018993	0.000214	0.06	0.1	41.36	28.32	4.30E-13	99.6	0	0	2.34	25.8	6.8	60.65	+-	0.09
tf2*	17.538	0.017943	0.000127	0.04	0.08	91.53	90.95	2.10E-13	99.8	0	0	3.74	27.31	3.3	60.45	+-	0.12
tf7	17.742	0.09126	0.000921	0.06	0.06	25.23	23.63	5.30E-13	98.5	0	0.01	2.62	5.37	8.5	60.36	+-	0.22
tf8	17.635	0.01478	0.000385	0.05	0.07	41.85	20.45	4.20E-13	99.4	0	0	1.01	33.15	6.7	60.52	+-	0.1
tf9	17.559	0.05866	0.000452	0.09	0.06	19.74	16.27	3.20E-13	99.3	0	0	3.43	8.35	5.1	60.2	+-	0.1
tf10	17.583	0.03627	0.000406	0.04	0.07	19.84	21.39	3.60E-13	99.3	0	0	2.36	13.51	5.7	60.32	+-	0.1
tf11	17.641	0.03614	0.000699	0.06	0.08	60.59	29.33	5.80E-13	98.8	0	0	1.37	13.56	9.3	60.23	+-	0.21
tf12	17.651	0.007196	0.000526	0.07	0.11	272.74	35.01	6.30E-13	99.1	0	0	0.36	68.09	10.1	60.43	+-	0.2
tf13	17.704	0.04584	0.000824	0.08	0.1	35.67	18.05	8.60E-13	98.6	0	0	1.47	10.69	13.7	60.32	+-	0.16
fs14	17.617	0.18316	0.000931	0.06	0.06	10.58	19.34	7.30E-13	98.5	0	0.01	5.19	2.67	11.8	59.96	+-	0.18
MT3		sanidine		J =	0.0019	+-	4.8E-06	(1 s.d.)		Exp. No.: 3I0071.IHD		Total gas age =			60.48	+-	0.16
tf5	18.114	0.04269	0.000881	0.05	0.12	96.91	28.65	1.60E-13	98.6	0	0	1.28	11.48	9.1	60.22	+-	0.26
tf6	17.986	0.05444	0.000376	0.04	0.04	45.37	48.81	2.80E-13	99.4	0	0	3.82	9	15.7	60.29	+-	0.18
tf7	18.275	0.10471	0.001039	0.04	0.1	57.27	36.42	1.10E-13	98.4	0	0.01	2.66	4.68	6.3	60.62	+-	0.37
tf8	18.138	0.03954	0.000579	0.03	0.09	109.51	44.99	1.60E-13	99.1	0	0	1.8	12.39	8.7	60.6	+-	0.26
tf9	18.12	0.04305	0.000417	0.05	0.11	118.93	79.44	1.30E-13	99.3	0	0	2.72	11.38	7.3	60.7	+-	0.32
tf10	18.115	0.03769	0.000327	0.06	0.09	126.9	87.55	1.40E-13	99.5	0	0	3.04	13	7.9	60.77	+-	0.28
tf11	18.071	0.02231	0.000072	0.05	0.08	218.26	426.26	1.40E-13	99.9	0	0	8.15	21.96	7.9	60.87	+-	0.28
TF1	18.154	0.007067	0.000666	0.07	0.1	925.97	27.18	1.40E-13	98.9	0	0	0.28	69.34	8	60.55	+-	0.19
TF2	18.115	0.016704	0.000662	0.06	0.13	505.83	42.07	1.10E-13	98.9	0	0	0.67	29.33	6.2	60.43	+-	0.28
TF3	18.038	0.04385	0.000552	0.05	0.06	91.08	19.2	2.30E-13	99.1	0	0	2.1	11.17	13.1	60.29	+-	0.11
TF4	18.041	0.009606	0.000498	0.04	0.05	558.23	30.55	1.70E-13	99.2	0	0	0.51	51.01	9.8	60.34	+-	0.15
MT3		Sanidine		J =	0.00195	+-	0	(1 s.d.)		Exp. No.: 3I5124.IHD		Total gas age =			59.71	+-	0.06
2.9	20.13	0.016523	0.012486	0.1	0.33	100	2.83	1.60E-14	81.7	0	0	0.03	29.66	2.6	57.01	+-	0.43
3	17.596	0.02477	0.004433	0.15	0.27	100	6.88	1.10E-14	92.6	0	0	0.15	19.78	1.7	56.49	+-	0.36
3.1	18.18	0.02065	0.004811	0.19	0.33	100	9.32	6.60E-15	92.2	0	0	0.11	23.73	1	58.1	+-	0.51
3.3	17.152	0.016392	0.003244	0.13	0.36	100	8.82	1.60E-14	94.4	0.01	0	0.13	29.89	2.6	56.17	+-	0.36
3.4	17.316	0.019455	0.000712	0.08	0.19	100	3.1	2.20E-13	98.8	0	0	0.72	25.19	32.7	59.29	+-	0.13
3.6	17.621	0.0236	0.000716	0.12	0.25	100	16.92	3.00E-14	98.8	0	0	0.87	20.77	4.5	60.32	+-	0.21
3.9	17.441	0.02013	0.000254	0.08	0.14	100	10.48	1.40E-13	99.6	0	0	2.09	24.34	21.1	60.17	+-	0.1
4.4	17.576	0.02241	0.000419	0.06	0.28	100	13.23	6.40E-14	99.3	0	0	1.41	21.86	9.5	60.47	+-	0.18
10	17.624	0.017446	0.00062	0.04	0.08	100	3.74	1.60E-13	99	0	0	0.74	28.09	24.3	60.43	+-	0.07
MT3		Sanidine		J =	0.00195	+-	5.9E-06	(1 s.d.)		Exp. No.: 3I5125.IHD		Total gas age =			60.17	+-	0.19
1.6	19.095	0.02126	0.005469	0.27	0.37	100	8.78	6.80E-15	91.5	0	0	0.1	23.05	2.1	60.56	+-	0.56
1.9	19.342	0.017656	0.007649	0.41	0.44	100	21.72	2.40E-15	88.3	0	0	0.06	27.75	0.8	59.2	+-	1.7

2.2	19.592	0.02414	0.009104	0.22	0.32	100	10.71	5.80E-15	86.3	0	0	0.07	20.29	1.9	58.59	+-	1.01
2.7	17.648	0.01622	0.000775	0.09	0.14	100	4.56	8.90E-14	98.7	0	0	0.55	30.21	28	60.35	+-	0.11
3	17.435	0.018687	0.000305	0.09	0.1	100	9.12	1.50E-13	99.5	0	0	1.62	26.22	48.6	60.1	+-	0.09
3.3	17.729	0.019669	0.001138	0.08	0.2	100	7.55	3.70E-14	98.1	0	0	0.46	24.91	11.5	60.26	+-	0.16
3.6	20.03	0.0244	0.008667	0.16	0.29	100	6.36	5.90E-15	87.2	0	0	0.07	20.08	1.9	60.52	+-	0.59
4	17.747	0.013901	0.001437	0.18	0.21	100	20.36	1.00E-14	97.6	0	0	0.26	35.25	3.3	60.02	+-	0.33
fuse	17.898	0.02235	0.001861	0.19	0.48	100	24.55	6.40E-15	96.9	0	0	0.32	21.92	2	60.11	+-	0.55
MT3		Sanidine		J =	0.00195	+-	5.9E-06	(1 s.d.)		Exp. No.: 9I5126.IHD		Total gas age =			60.33	+-	0.19
1.7	18.872	0.01945	0.004766	0.16	0.19	100	8.69	7.40E-15	92.5	0	0	0.11	25.19	3	60.5	+-	0.44
2	18.408	0.02055	0.002935	0.17	0.41	100	15.31	7.10E-15	95.3	0	0	0.18	23.85	2.8	60.77	+-	0.53
2.3	17.815	0.016925	0.00139	0.08	0.13	100	13.04	1.70E-14	97.7	0	0	0.32	28.95	6.8	60.3	+-	0.21
2.6	17.501	0.014412	0.000564	0.07	0.15	100	5.31	1.00E-13	99.1	0	0	0.68	34	39.9	60.06	+-	0.11
2.8	17.799	0.02607	0.001052	0.07	0.14	100	5.22	5.60E-14	98.3	0	0	0.65	18.8	22.1	60.59	+-	0.11
3	18.014	0.018164	0.001987	0.1	0.16	100	6.82	2.40E-14	96.7	0	0	0.24	26.98	9.5	60.38	+-	0.18
3.5	17.747	0.01966	0.000983	0.1	0.16	100	8.24	3.70E-14	98.4	0	0	0.53	24.92	14.6	60.48	+-	0.14
4.5	19.872	0.0206	0.007932	0.34	0.38	100	10.5	3.50E-15	88.2	0	0	0.07	23.79	1.4	60.72	+-	0.9
MT3		Sanidine		J =	0.00195	+-	5.9E-06	(1 s.d.)		Exp. No.: 9I5129.IHD		Total gas age =			60.69	+-	0.19
1.3	18.669	0.02328	0.00283	0.17	0.11	100	21.22	6.40E-15	95.5	0	0	0.22	21.04	2.8	61.76	+-	0.61
1.7	30.61	0.02323	0.03611	1.07	2.46	100	18.45	7.20E-16	65.1	0	0	0.02	21.09	0.3	68.93	+-	7.23
2.1	17.638	0.0251	0.000938	0.12	0.13	100	32.86	1.20E-14	98.4	0	0	0.71	19.52	5.1	60.16	+-	0.33
2.3	17.665	0.02252	0.000549	0.04	0.07	100	10.24	6.60E-14	99.1	0	0	1.08	21.76	28.5	60.64	+-	0.08
2.4	17.704	0.02517	0.000573	0.05	0.16	100	11.44	5.90E-14	99	0	0	1.16	19.46	25.6	60.75	+-	0.12
2.5	17.837	0.018855	0.001416	0.09	0.31	100	18.24	1.60E-14	97.7	0	0	0.35	25.99	6.8	60.35	+-	0.32
2.8	17.676	0.015148	0.000598	0.07	0.12	100	33.75	2.00E-14	99	0	0	0.67	32.35	8.5	60.62	+-	0.22
10	17.92	0.017259	0.001345	0.07	0.11	100	6.19	5.10E-14	97.8	0	0	0.34	28.39	22.4	60.71	+-	0.12
MT3		sanidine		J =	0.00195	+-	5.9E-06	(1 s.d.)		Exp. No.: 9I5147.IHD		Total gas age =			60.5	+-	0.19
1.7	18.159	0.013202	0.001868	0.12	0.16	100	10.33	1.30E-14	97	0	0	0.19	37.12	5.8	60.99	+-	0.23
1.8	17.57	0.011497	0.0005	0.11	0.24	100	34.74	1.50E-14	99.2	0	0	0.61	42.62	6.7	60.36	+-	0.24
1.9	17.57	0.011497	0.000468	0.11	0.24	100	36.58	1.50E-14	99.2	0	0	0.65	42.62	6.7	60.39	+-	0.23
2	17.537	0.012087	0.00037	0.11	0.22	100	16.1	4.30E-14	99.4	0	0	0.86	40.54	19.1	60.38	+-	0.16
2.1	17.545	0.012549	0.00032	0.2	0.32	100	30.09	2.80E-14	99.5	0	0	1.04	39.05	12.3	60.46	+-	0.25
2.2	17.576	0.019423	0.000605	0.13	0.23	100	25.56	1.80E-14	99	0	0	0.85	25.23	7.9	60.28	+-	0.22
2.4	17.566	0.009506	0.000338	0.06	0.13	100	21.36	3.70E-14	99.4	0	0	0.74	51.55	16.2	60.51	+-	0.11
2.6	17.663	0.013812	0.000561	0.08	0.14	100	9.71	5.00E-14	99.1	0	0	0.65	35.48	22.3	60.62	+-	0.12
fuse	18.253	0.012621	0.002365	0.23	0.35	100	16.05	6.90E-15	96.2	0	0	0.14	38.82	3.1	60.81	+-	0.46
MT2		Sanidine		J =	0.00195	+-	4.9E-06	(1 s.d.)		Exp. No.: 9I0028.IHD		Total gas age =			60.5	+-	0.15
tf1	17.518	0.012853	0.000149	0.02	0.08	96.27	56.24	2.80E-13	99.7	0	0	2.27	38.12	7.2	60.51	+-	0.1
tf2	17.574	0.006821	0.000184	0.03	0.1	258.93	71.4	1.90E-13	99.7	0	0	0.98	71.84	4.9	60.66	+-	0.14
tf3	17.565	0.015805	0.000155	0.02	0.13	82.96	63.69	2.60E-13	99.7	0	0	2.69	31	6.6	60.66	+-	0.12
tf4	17.535	0.04484	0.000067	0.06	0.11	40.91	234.49	1.90E-13	99.9	0	0	17.54	10.93	4.7	60.66	+-	0.15
tf5	17.502	0.03763	0.000223	0.05	0.18	36.49	42.82	2.50E-13	99.6	0	0	4.46	13.02	6.4	60.38	+-	0.14
tf6	17.803	0.02679	0.000855	0.05	0.12	53.62	11.43	2.40E-13	98.6	0	0	0.83	18.29	6	60.77	+-	0.13
tf7	17.565	0.03516	0.000339	0.05	0.07	42.04	23.03	2.70E-13	99.4	0	0	2.74	13.94	6.8	60.48	+-	0.09
tf8	17.415	0.02161	0.000165	0.04	0.08	39.29	28.09	4.00E-13	99.7	0	0	3.45	22.67	10.1	60.14	+-	0.07
tf9	17.268	0.005607	0.000348	0.06	0.06	175.94	16.73	3.40E-13	99.4	0	0	0.42	87.39	8.8	59.45	+-	0.08
tf10	17.568	0.015519	0.000224	0.05	0.05	81.86	29.22	2.70E-13	99.6	0	0	1.83	31.57	6.9	60.6	+-	0.08

tf11	17.571	0.01569	0.000358	0.04	0.15	96.58	24.01	2.20E-13	99.4	0	0	1.16	31.23	5.7	60.48	+-	0.13
tf12	17.605	0.02403	0.000185	0.06	0.09	25.34	39.48	6.10E-13	99.7	0	0	3.42	20.39	15.4	60.77	+-	0.1
tf13	17.636	0.02135	0.000151	0.06	0.08	38.89	29.89	4.20E-13	99.8	0	0	3.74	22.95	10.6	60.91	+-	0.08
MT2		sanidine		J =	0.00191	+-	4.8E-06	(1 s.d.)	Exp. No.: 3I0070.IHD			Total gas age =			60.89	+-	0.2
TF1	18.344	0.05713	0.001456	0.07	0.13	181.73	20.66	9.00E-14	97.7	0	0	1.04	8.58	9.8	60.71	+-	0.3
TF2	18.409	0.016077	0.000448	0.11	0.16	892.67	89.31	6.70E-14	99.3	0	0	0.95	30.48	7.2	61.9	+-	0.4
TF3	18.159	0.007773	0.000778	0.07	0.14	100	36.34	8.50E-14	98.7	0	0	0.26	63.04	9.3	60.74	+-	0.29
TF4	18.179	0.006614	0.000662	0.05	0.11	100	47.28	1.00E-13	98.9	0	0	0.26	74.08	10.9	60.92	+-	0.31
TF5	17.996	0.007385	0.000706	0.07	0.09	1183.13	50.81	1.10E-13	98.8	0	0	0.28	66.35	11.7	60.27	+-	0.35
TF6	18.316	0.04349	0.001272	0.1	0.14	311.01	48.05	6.90E-14	98	0	0	0.9	11.27	7.5	60.79	+-	0.59
TF8	18.575	0.08988	0.00218	0.11	0.21	196.8	30.53	5.30E-14	96.6	0	0.01	1.09	5.45	5.8	60.77	+-	0.65
TF7	18.238	0.12291	0.000927	0.09	0.13	94.3	47.38	8.20E-14	98.5	0	0.01	3.5	3.99	8.9	60.89	+-	0.42
tf9	18.388	0.03583	0.001097	0.07	0.12	314.75	28.73	8.40E-14	98.2	0	0	0.86	13.67	9.1	61.2	+-	0.31
tf10	18.68	0.10399	0.002602	0.19	0.35	172.99	33.18	5.80E-14	95.9	0	0.01	1.06	4.71	6.3	60.71	+-	0.85
tf11	18.582	0.04513	0.001738	0.12	0.19	383.35	33.53	5.50E-14	97.3	0	0	0.69	10.86	6	61.22	+-	0.57
tf12	18.276	0.019384	0.000917	0.08	0.19	100	53.95	6.90E-14	98.5	0	0	0.56	25.28	7.5	61	+-	0.49
MT2		Sanidine		J =	0.00196	+-	5.9E-06	(1 s.d.)	Exp. No.: 3I5121.IHD			Total gas age =			60.65	+-	0.23
0.9	17.748	0.005491	0.000549	0.08	0.13	100	27.38	2.60E-14	99.1	0	0	0.26	89.24	24.8	61.01	+-	0.18
1.1	18.46	0.009045	0.003748	0.08	0.26	100	9.21	1.60E-14	94	0	0	0.06	54.17	15.1	60.21	+-	0.39
1.4	22.01	0.018375	0.01485	0.18	0.32	100	4.16	7.80E-15	80.1	0	0	0.03	26.67	7.4	61.13	+-	0.68
2.3	18.318	0.02422	0.00327	0.38	0.69	100	40.73	2.90E-15	94.7	0	0	0.2	20.23	2.8	60.22	+-	1.42
2.6	17.682	0.005619	0.00083	0.07	0.27	100	17.42	2.50E-14	98.6	0	0	0.18	87.21	24.3	60.5	+-	0.22
1.8	18.003	0.011525	0.001825	0.11	0.18	100	18.34	1.20E-14	97	0	0	0.17	42.51	11.9	60.59	+-	0.36
3	17.808	0.016198	0.00089	0.19	0.36	100	47.7	8.80E-15	98.5	0	0	0.48	30.25	8.4	60.87	+-	0.49
3.4	18.239	0.00431	0.002741	0.38	0.45	100	42.21	3.30E-15	95.6	0	0	0.04	113.7	3.2	60.47	+-	1.21
10	19.288	0.01398	0.006754	0.54	0.59	100	27.04	2.00E-15	89.7	0	0	0.05	35.05	2	60.01	+-	1.9
MT2		Sanidine		J =	0.00196	+-	5.9E-06	(1 s.d.)	Exp. No.: 3I5127.IHD			Total gas age =			60.55	+-	0.2
1.7	17.933	0.008679	0.001589	0.12	0.27	100	11.51	1.70E-14	97.4	0	0	0.14	56.46	9.6	60.59	+-	0.26
1.8	17.822	0.019682	0.001159	0.17	0.37	100	17.3	1.50E-14	98.1	0	0	0.45	24.89	8.5	60.65	+-	0.32
1.8*	17.972	0.017769	0.002052	0.09	0.18	100	10.74	1.60E-14	96.6	0	0	0.23	27.58	9.4	60.26	+-	0.25
1.8+	17.906	0.017395	0.001555	0.1	0.21	100	7.48	2.50E-14	97.4	0	0	0.3	28.17	14.4	60.54	+-	0.19
2.1	18.25	0.02019	0.002105	0.14	0.28	100	10.05	1.50E-14	96.6	0	0	0.25	24.26	8.3	61.16	+-	0.29
2.2	17.885	0.013371	0.001656	0.08	0.1	100	7.24	3.30E-14	97.3	0	0	0.21	36.65	18.7	60.36	+-	0.15
2.4	18.01	0.018718	0.001795	0.08	0.22	100	9.3	2.30E-14	97.1	0	0	0.28	26.18	13.4	60.65	+-	0.22
3	17.938	0.01701	0.001985	0.11	0.2	100	6.62	2.60E-14	96.7	0	0	0.23	28.81	14.7	60.21	+-	0.19
10	19.549	0.013404	0.005974	0.21	0.45	100	12.27	5.50E-15	91	0	0	0.06	36.56	3.1	61.68	+-	0.8
MT2		Sanidine		J =	0.00196	+-	5.9E-06	(1 s.d.)	Exp. No.: 3I5128.IHD			Total gas age =			60.69	+-	0.24
1	17.823	0.012746	0.001292	0.06	0.21	100	15.96	2.30E-14	97.9	0	0	0.26	38.44	26.6	60.52	+-	0.25
1.3	17.932	0.019639	0.001838	0.11	0.26	100	17.18	1.50E-14	97	0	0	0.28	24.95	17.3	60.34	+-	0.36
1.7	21.66	0.015661	0.012424	0.2	0.25	100	9.15	4.80E-15	83.1	0	0	0.03	31.29	5.4	62.4	+-	1.16
1.8	17.75	0.009442	0.001388	0.12	0.17	100	22.58	1.50E-14	97.7	0	0	0.18	51.89	18	60.17	+-	0.34
2.2	18.373	0.02118	0.002643	0.1	0.33	100	15.37	1.40E-14	95.8	0	0	0.21	23.13	16	61.03	+-	0.46
10	17.96	0.02019	0.001288	0.13	0.26	100	25.02	1.50E-14	97.9	0	0	0.41	24.27	16.8	60.99	+-	0.37
MT2		sanidine		J =	0.00196	+-	5.9E-06	(1 s.d.)	Exp. No.: 3I5146.IHD			Total gas age =			60.35	+-	0.2

1.4	17.708	0.016035	0.001138	0.15	0.17	100	21.15	1.10E-14	98.1	0	0	0.37	30.56	9.2	60.28	+-	0.28
1.6	17.771	0.0203	0.00177	0.3	0.52	100	35.94	4.20E-15	97.1	0	0	0.3	24.14	3.6	59.86	+-	0.73
1.7	17.525	0.017838	0.000796	0.09	0.21	100	16.87	1.90E-14	98.7	0	0	0.59	27.47	16.5	60	+-	0.19
1.8	17.528	0.011445	0.000941	0.16	0.1	100	20.58	1.50E-14	98.4	0	0	0.32	42.81	12.8	59.87	+-	0.22
2.1	17.765	0.01298	0.00135	0.21	0.43	100	28.45	6.60E-15	97.8	0	0	0.25	37.75	5.7	60.26	+-	0.48
2.5	17.62	0.011261	0.000524	0.06	0.17	100	16.33	3.10E-14	99.1	0	0	0.57	43.51	26.1	60.6	+-	0.14
3.2	18.118	0.009449	0.00207	0.08	0.2	100	8.43	1.80E-14	96.6	0	0	0.12	51.86	15.6	60.74	+-	0.22
10	17.581	0.013862	0.000406	0.12	0.34	100	51.36	1.30E-14	99.3	0	0	0.9	35.35	10.6	60.58	+-	0.3
MT2		sanidine		J =	0.00265	+-	8E-06	(1 s.d.)		Exp. No.: 3I5209.IHD		Total gas age =			60.51	+-	0.18
dgs1	13.004	0.008094	0.000451	0.05	0.15	1.91	14.86	2.60E-14	99	0	0	0.49	60.54	1.7	60.57	+-	0.13
dgs2	12.994	0.02176	0.00072	0.1	0.25	2.65	34.64	6.00E-15	98.4	0	0	0.82	22.52	0.4	60.16	+-	0.37
dgs3	13.024	0.02013	0.000878	0.07	0.19	2.09	22.11	8.50E-15	98	0	0	0.63	24.35	0.5	60.08	+-	0.28
dgs4	13.756	0.02111	0.002463	0.12	0.31	2.93	12.9	5.20E-15	94.7	0	0	0.23	23.21	0.3	61.31	+-	0.47
dgs5	13.12	0.02039	0.000681	0.1	0.13	1.69	22.45	1.00E-14	98.5	0	0	0.82	24.04	0.7	60.8	+-	0.23
dgs6	13.013	0.018246	0.000955	0.1	0.26	1.31	10.5	1.50E-14	97.8	0	0	0.52	26.86	1	59.93	+-	0.21
dg7*	12.922	0.017347	0.00023	0.04	0.03	0.33	5.99	1.80E-13	99.5	0	0	2.06	28.25	11.5	60.5	+-	0.05
fs1	12.946	0.006405	0.000286	0.04	0.06	1.09	7.1	1.40E-13	99.3	0	0	0.61	76.51	8.9	60.53	+-	0.06
fs2	12.901	0.02093	0.000194	0.02	0.11	0.45	11.28	9.10E-14	99.6	0	0	2.95	23.42	5.8	60.46	+-	0.08
fs3	12.94	0.02125	0.000121	0.03	0.06	0.68	13.02	1.70E-13	99.7	0	0	4.81	23.06	10.9	60.73	+-	0.05
fs4	12.897	0.018746	0.000189	0.02	0.07	0.97	16.91	8.80E-14	99.6	0	0	2.71	26.14	5.6	60.44	+-	0.06
fs5	12.945	0.02056	0.000319	0.05	0.08	0.65	6.51	1.20E-13	99.3	0	0	1.76	23.83	7.8	60.49	+-	0.07
fs6	12.898	0.02034	0.000182	0.12	0.09	0.74	30.42	5.40E-14	99.6	0	0	3.05	24.09	3.4	60.46	+-	0.12
fs7	12.91	0.009022	0.000078	0.02	0.07	0.97	15.85	1.80E-13	99.8	0	0	3.17	54.31	11.5	60.65	+-	0.05
fs8	12.898	0.00809	0.000104	0.02	0.04	1.08	12.39	1.70E-13	99.8	0	0	2.12	60.57	11.1	60.56	+-	0.04
fs9	12.873	0.015384	0.000189	0.06	0.09	1.19	27.52	5.20E-14	99.6	0	0	2.22	31.85	3.3	60.33	+-	0.1
fs10	12.872	0.015266	0.000143	0.04	0.08	0.78	33.08	6.80E-14	99.7	0	0	2.92	32.1	4.4	60.39	+-	0.08
fs11	12.819	0.02612	0.000131	0.05	0.1	0.59	28.49	6.50E-14	99.7	0	0	5.44	18.76	4.2	60.16	+-	0.09
fs12	12.865	0.013392	0.000114	0.08	0.1	2.1	54.58	3.90E-14	99.7	0	0	3.21	36.59	2.5	60.39	+-	0.11
fs13	12.89	0.02163	0.000227	0.05	0.07	0.78	16.61	7.30E-14	99.5	0	0	2.61	22.65	4.7	60.36	+-	0.08
Muck T752		wr core		J =	0.00271	+-	8.1E-06	(1 s.d.)		Exp. No.: 3I0020.IHD		Total gas age =			83.5	+-	5.83
12	984.9	-7.818605	2.825	0.48	5.36	-14.4	3.54	1.30E-13	15.2	0	-0.53	-0.07	-0.063	1.7	611.2	+-	260.2
13	236.2	9.53	0.7169	0.27	0.75	1.55	1.92	8.20E-15	10.6	0	0.64	0.35	0.051	0.6	119.34	+-	21.4
14.2	252.1	7.471	0.7699	0.3	0.85	2.46	2.04	7.20E-15	10	0	0.5	0.26	0.065	0.5	119.76	+-	24.87
15.5	89.79	6.134	0.2505	0.1	0.13	0.44	0.66	4.40E-14	18.1	0	0.41	0.65	0.08	5.2	78.01	+-	2.44
17	62.84	5.499	0.16142	0.16	0.15	0.46	1.34	3.20E-14	24.8	0	0.37	0.9	0.089	4	74.84	+-	3.02
18.5	60.8	5.226	0.15463	0.16	0.17	0.46	1.29	3.50E-14	25.5	0	0.35	0.89	0.093	4.3	74.57	+-	2.81
20	75.52	5.594	0.2016	0.08	0.11	0.32	0.64	8.70E-14	21.7	0	0.38	0.73	0.087	10.1	78.72	+-	1.89
21.5	51.34	5.314	0.1221	0.09	0.09	0.22	0.79	2.00E-13	30.5	0	0.36	1.15	0.092	24.9	75.32	+-	1.37
23	39.58	6.18	0.0874	0.13	0.11	0.27	1.27	6.00E-14	36	0	0.42	1.87	0.079	8	68.59	+-	1.53
25	42.08	7.433	0.09497	0.38	0.2	0.56	3.61	1.90E-14	34.7	0	0.5	2.07	0.066	2.5	70.34	+-	4.67
28	43.85	8.838	0.09907	0.21	0.16	0.26	2.05	3.40E-14	34.8	0	0.59	2.36	0.055	4.3	73.57	+-	2.77
32	30.68	8.158	0.05907	0.18	0.11	0.19	2.09	5.20E-14	45.2	0	0.55	3.65	0.06	7.1	66.88	+-	1.66
37	18.462	6.86	0.02028	0.35	0.11	0.25	7.3	4.20E-14	70.4	0	0.46	8.93	0.071	6.2	62.78	+-	1.87
43	26.14	44.28	0.05624	0.19	0.08	0.11	2.3	5.60E-14	49.6	0	2.98	20.79	0.0107	8	64.27	+-	1.47
50	25.88	35.26	0.04571	0.13	0.1	0.08	1.86	1.00E-13	58.4	0	2.37	20.36	0.0136	12.6	74.23	+-	0.97
SR539		hornblende		J =	0.00094	+-	2.8E-06	(1 s.d.)		Exp. No.: 3I5093.IHD		Total gas age =			73.11	+-	0.29
dgs	74.01	0.2527	0.11953	0.1	0.25	2.32	0.91	2.20E-14	52.3	0	0.02	0.06	1.939	13.2	64.15	+-	0.64
fs10	362.1	6.599	0.9318	0.1	0.68	0.94	1.76	4.00E-15	24.1	0	0.46	0.19	0.074	1.1	142.08	+-	9.03

fs11	49.4	0.5853	0.011731	0.07	0.13	0.33	1.35	1.20E-13	93.1	0	0.04	1.36	0.837	61.2	75.96	+-	0.14
fs13	43.27	0.749	0.012335	0.13	0.19	1.54	3.3	3.90E-14	91.7	0	0.05	1.66	0.654	23	65.76	+-	0.26
fs15	186.09	11.16	0.5144	0.23	1.77	0.94	5.93	4.50E-16	18.8	0	0.78	0.59	0.044	0.3	58.54	+-	16.34
fs16	170.87	3.593	0.4166	0.16	1.41	2.49	2.92	1.50E-15	28.1	0	0.25	0.24	0.136	0.7	79.46	+-	7.58
fs17	323.8	21.36	0.8048	0.08	1.28	1.3	2.36	1.90E-15	27.1	0	1.49	0.72	0.023	0.5	144.29	+-	11.96
SR 539		Hornblende		J =	0.00093	+-	2.8E-06	(1 s.d.)		Exp. No.: 9I5119.IHD		Total gas age =			64.75	+-	0.27
3	58.75	0.2263	0.0566	0.05	0.37	2.96	1.37	2.80E-14	71.6	0	0.02	0.11	2.17	25.5	69.43	+-	0.53
3.4	46.7	0.3197	0.018471	0.12	0.44	4.98	5.86	8.80E-15	88.4	0	0.02	0.47	1.532	8.2	68.17	+-	0.62
3.8	46.93	0.5569	0.02173	0.22	0.49	2.56	5.31	6.20E-15	86.4	0	0.04	0.7	0.88	5.8	67.02	+-	0.69
3.9	45.46	0.7441	0.019335	0.15	0.25	1.77	5.08	1.00E-14	87.6	0	0.05	1.05	0.658	10.1	65.82	+-	0.51
4	42.56	0.9803	0.017325	0.09	0.42	1.4	3.48	1.40E-14	88.2	0	0.07	1.54	0.5	14.5	62.11	+-	0.42
4.1	58.4	0.7234	0.07579	0.32	0.82	5.79	3.92	2.50E-15	61.7	0	0.05	0.26	0.677	2.7	59.72	+-	1.68
5	44.72	0.8714	0.02526	0.15	0.53	4.03	3.53	9.50E-15	83.5	0	0.06	0.94	0.562	9.8	61.79	+-	0.59
10	43.54	0.2917	0.023	0.08	0.17	3.17	2.4	2.20E-14	84.4	0	0.02	0.35	1.679	23.4	60.85	+-	0.3
SR 539		Hornblende		J =	0.00093	+-	2.8E-06	(1 s.d.)		Exp. No.: 9I5120.IHD		Total gas age =			63.93	+-	0.24
3	64.08	0.11818	0.0806	0.03	0.07	2.31	0.53	4.70E-14	62.8	0	0.01	0.04	4.15	31	66.58	+-	0.23
3.2	43.57	0.14885	0.009483	0.07	0.37	4.82	4.97	2.40E-14	93.6	0	0.01	0.43	3.29	15.4	67.41	+-	0.35
3.4	42.53	0.504	0.012614	0.15	0.46	2.02	7.47	1.30E-14	91.3	0	0.04	1.09	0.972	8.8	64.28	+-	0.56
3.6	43.61	0.4649	0.02006	0.16	0.13	2.6	4.9	1.10E-14	86.5	0	0.03	0.63	1.054	7.9	62.46	+-	0.49
3.9	45.62	0.4862	0.02862	0.18	0.48	2.67	4.97	7.70E-15	81.5	0	0.03	0.46	1.007	5.5	61.62	+-	0.78
4.4	46.03	0.4808	0.03283	0.17	0.35	2.64	2.67	9.80E-15	79	0	0.03	0.4	1.019	7.1	60.25	+-	0.51
fuse	49.53	0.3504	0.04449	0.07	0.22	0.95	0.89	3.40E-14	73.5	0	0.02	0.22	1.398	24.4	60.32	+-	0.28
SR475		Biotite		J =	0.00093	+-	4.7E-06	(1 s.d.)		Exp. No.: 9I5099.IHD		Total gas age =			53.3	+-	0.68
dgs	106.86	1.9201	0.247	0.22	0.77	2.71	2.15	2.10E-15	31.8	0	0.13	0.21	0.255	5.5	56.51	+-	3.06
fs8	46.76	2.782	0.03659	0.09	0.09	0.33	1.09	3.30E-14	77.4	0	0.19	2.08	0.176	79.8	60.05	+-	0.22
fs9	88.36	16.389	0.1969	0.32	0.6	0.37	3.88	1.30E-15	35.6	0	1.15	2.27	0.03	3.7	52.91	+-	3.84
dgs7	553	0.02526	1.8677	0.07	0.32	52.39	0.29	1.40E-16	0.2	0	0	0	19.4	11	1.869	+-	5.256
Eigg T908		wr core		J =	0.00271	+-	8.1E-06	(1 s.d.)		Exp. No.: 9f0021.IHD		Total gas age =			54.12	+-	0.28
12	23.33	4.014	0.06437	0.14	0.16	0.28	0.53	5.80E-14	19.8	0	0.27	1.65	0.122	7.8	22.52	+-	0.57
13	16.079	4.939	0.0352	0.27	0.55	0.93	3.14	3.30E-14	37.7	0.01	0.33	3.7	0.099	3.4	29.5	+-	1.58
14	15.064	6.042	0.019054	0.2	0.21	0.32	2.2	7.80E-14	65.7	0.01	0.41	8.37	0.081	4.9	47.99	+-	0.58
15	13.324	6.985	0.007523	0.14	0.12	0.16	4.39	1.40E-13	87.4	0.01	0.47	24.51	0.07	7.6	56.33	+-	0.36
16	13.441	7.391	0.00631	0.21	0.18	0.2	8.48	9.90E-14	90.4	0.01	0.5	30.92	0.066	5.1	58.76	+-	0.54
17.5	14.056	6.539	0.007468	0.06	0.07	0.13	1.91	3.60E-13	87.9	0.01	0.44	23.11	0.075	18.1	59.71	+-	0.17
19	15.915	4.462	0.012206	0.86	0.89	1.5	17.46	1.90E-14	79.5	0.01	0.3	9.65	0.109	0.9	61.03	+-	2.8
21	15.552	5.138	0.011321	0.35	0.36	0.55	7.69	4.80E-14	81.1	0.01	0.35	11.98	0.095	2.4	60.83	+-	1.11
23.5	15.795	5.671	0.012899	0.21	0.23	0.29	3.86	8.30E-14	78.7	0.01	0.38	11.61	0.086	4.2	59.99	+-	0.65
26	20.56	6.75	0.02881	0.13	0.16	0.25	0.99	1.40E-13	61.2	0	0.45	6.19	0.072	6.9	60.74	+-	0.42
29	28.42	7.392	0.05574	0.11	0.16	0.15	0.57	1.30E-13	44.1	0	0.5	3.5	0.066	6.3	60.53	+-	0.53
33	18.785	5.271	0.02324	0.12	0.1	0.14	0.92	1.90E-13	65.6	0	0.35	5.99	0.093	9.4	59.52	+-	0.32
37	19.326	4.492	0.02644	0.4	0.49	0.85	4.35	2.20E-13	61.4	0	0.3	4.48	0.109	11.7	57.27	+-	1.62
42	20.1	68.2	0.05124	0.1	0.12	0.05	0.77	1.30E-13	51.1	0	4.59	35.14	0.0069	7.4	51.92	+-	0.43
50	18.771	64.52	0.04227	0.2	0.25	0.07	1.96	6.70E-14	60.3	0	4.34	40.29	0.0073	3.6	56.93	+-	0.79
60	23.73	62.15	0.05595	1.13	1.79	0.24	9.72	9.30E-15	50.8	0	4.18	29.32	0.0076	0.5	60.44	+-	6.14
MKD1		wr lch 250-500		J =	0.00204	+-	6.1E-06	(1 s.d.)		Exp. No.: 9f0116.IHD		Total gas age =			71.4	+-	0.26

13	92.97	4.822	0.2238	0.03	0.41	55.24	0.92	3.20E-14	29.3	0	0.32	0.57	0.101	0.7	97.83	+-	2.6
14	57.02	5.658	0.12338	0.02	0.11	13.12	0.57	8.90E-14	36.8	0	0.38	1.21	0.086	2.6	76.02	+-	0.79
15	43.59	5.216	0.08025	0.03	0.11	10.46	0.69	1.20E-13	46.5	0	0.35	1.72	0.094	3.5	73.46	+-	0.61
16	33.87	5.259	0.0497	0.02	0.05	6.28	0.64	1.90E-13	57.9	0	0.35	2.79	0.093	5.8	71.02	+-	0.34
17	27.33	6.472	0.03152	0.02	0.06	4.77	0.85	1.90E-13	67.8	0	0.44	5.42	0.075	6.2	67.24	+-	0.28
18	24.77	8.116	0.02512	0.05	0.16	9.09	2.22	7.70E-14	72.6	0	0.55	8.53	0.06	2.6	65.38	+-	0.56
19	28.11	11.254	0.03737	0.01	0.04	1.89	0.5	2.70E-13	63.8	0	0.76	7.95	0.043	9	65.39	+-	0.2
20	27.23	13.079	0.03583	0.03	0.05	1.54	0.54	2.80E-13	64.9	0	0.88	9.64	0.037	9.7	64.47	+-	0.21
21	27.73	11.88	0.03599	0.02	0.04	1.46	0.43	3.30E-13	65	0	0.8	8.71	0.041	11.2	65.72	+-	0.17
22	24.56	10.894	0.02674	0.05	0.11	5.18	1.71	9.80E-14	71.3	0	0.73	10.76	0.045	3.4	63.82	+-	0.45
23.2	25.64	9.486	0.02818	0.02	0.09	4.18	1.68	1.50E-13	70.4	0	0.64	8.88	0.051	4.9	65.7	+-	0.46
24.5	27.75	8.399	0.03462	0.02	0.06	3.98	0.67	1.70E-13	65.5	0	0.57	6.4	0.058	5.8	66.11	+-	0.25
26.5	34.11	5.606	0.05318	0.02	0.06	4.88	0.7	2.20E-13	55.2	0	0.38	2.78	0.087	7.2	68.33	+-	0.39
29	28.05	3.692	0.03558	0.02	0.07	4.24	0.49	3.60E-13	63.5	0	0.25	2.74	0.132	12.3	64.63	+-	0.2
32	29.58	13.86	0.04511	0.04	0.1	2.86	0.78	1.40E-13	58.6	0	0.93	8.11	0.035	4.9	63.33	+-	0.37
37	54.27	106.36	0.11212	0.04	0.4	2.9	1.46	4.00E-13	54.2	0	7.16	25.05	0.0043	7.7	113.18	+-	1.69
43	41.14	57.34	0.05595	0.04	0.19	3.7	1.73	8.20E-14	70.7	0	3.86	27.06	0.0082	1.7	108.11	+-	0.9
50	43.57	66.14	0.0709	0.05	0.33	3.77	1.78	4.30E-14	63.8	0	4.45	24.63	0.0071	0.9	104.03	+-	1.24
Eigg		sanidine		J =	0.00094	+-	2.8E-06	(1 s.d.)	Exp. No.: 3I5064.IHD			Total gas age =			60.34	+-	0.21
1.4	49.65	0.4733	0.02669	0.32	1.18	2.9	4.55	3.50E-15	84.2	0	0.03	0.48	1.035	3.2	69.81	+-	1.16
2.1	36.99	0.4727	0.005329	0.22	0.76	1.2	17.8	4.90E-15	95.8	0	0.03	2.42	1.036	5.1	59.38	+-	0.66
2.6	39.82	0.4906	0.003272	0.08	0.16	0.72	15.67	1.40E-14	97.7	0	0.03	4.09	0.998	13.2	65.03	+-	0.27
3.3	36.08	0.4348	0.001086	0.11	0.42	1.04	50.54	1.20E-14	99.2	0	0.03	10.93	1.127	12.8	59.94	+-	0.35
3.9	35.75	0.4232	0.001201	0.07	0.17	0.37	16.05	2.70E-14	99.1	0	0.03	9.62	1.158	28.3	59.34	+-	0.14
5.1	35.68	0.4582	0.002619	0.13	0.57	1	20.93	9.50E-15	97.9	0	0.03	4.78	1.069	10.2	58.53	+-	0.43
6	36.18	0.4607	0.003597	0.2	0.63	1.06	18.19	7.60E-15	97.2	0	0.03	3.5	1.063	8.2	58.9	+-	0.5
6.5	36.05	0.6841	0.002771	0.1	0.15	0.81	10.81	1.70E-14	97.9	0	0.05	6.74	0.716	17.9	59.12	+-	0.18
fuse	36.53	0.8686	0.005614	0.97	1.09	3.25	73.75	1.00E-15	95.6	0	0.06	4.22	0.564	1.1	58.55	+-	2.11
Eigg		sanidine		J =	0.00094	+-	2.8E-06	(1 s.d.)	Exp. No.: 3I5065.IHD			Total gas age =			58.48	+-	0.24
2.1	38.28	0.2979	0.009688	0.28	0.46	3.96	12.33	4.70E-15	92.6	0	0.02	0.84	1.645	6.4	59.36	+-	0.67
2.5	36.49	0.3064	0.006297	0.21	0.65	3.73	20.54	5.10E-15	95	0	0.02	1.33	1.599	7.1	58.05	+-	0.74
3	35.46	0.2552	0.001993	0.09	0.21	1.15	18.87	1.50E-14	98.4	0	0.02	3.49	1.92	20.4	58.45	+-	0.22
3.7	35.44	0.2511	0.001775	0.14	0.45	1.9	35.49	1.10E-14	98.6	0	0.02	3.86	1.951	15	58.52	+-	0.4
4.3	36.19	0.2559	0.004361	0.16	0.79	2.21	11.98	8.00E-15	96.5	0	0.02	1.6	1.914	11	58.5	+-	0.54
4.6	35.6	0.2518	0.002302	0.23	0.9	3.74	43.06	5.40E-15	98.1	0	0.02	2.99	1.945	7.4	58.53	+-	0.72
5.5	35.91	0.3032	0.009975	0.45	1.77	5.22	18.48	2.60E-15	91.9	0	0.02	0.83	1.616	3.8	55.31	+-	1.4
fuse	35.51	0.2466	0.001483	0.09	0.52	1.12	15.45	2.10E-14	98.8	0	0.02	4.54	1.986	28.8	58.78	+-	0.33
Eigg		sanidine		J =	0.00094	+-	2.8E-06	(1 s.d.)	Exp. No.: 3I5071.IHD			Total gas age =			58.54	+-	0.19
2.2	37.01	0.1431	0.006174	0.11	0.25	2.54	5.72	1.40E-14	95.1	0	0.01	0.63	3.42	8.8	58.85	+-	0.24
2.6	35.69	0.08925	0.00184	0.06	0.23	1.52	5.87	3.20E-14	98.5	0	0.01	1.32	5.49	20.3	58.78	+-	0.15
3	35.41	0.08757	0.001687	0.07	0.23	1.38	11.12	2.70E-14	98.6	0	0.01	1.42	5.6	16.9	58.39	+-	0.17
3.4	35.35	0.0922	0.001502	0.13	0.32	2.27	19.26	1.50E-14	98.8	0	0.01	1.68	5.31	9.5	58.38	+-	0.25
3.5	35.47	0.08989	0.001431	0.09	0.25	1.43	9.99	3.50E-14	98.8	0	0.01	1.72	5.45	22.3	58.61	+-	0.17
3.9	35.36	0.09131	0.001569	0.12	0.33	1.58	10.31	2.60E-14	98.7	0	0.01	1.59	5.37	16.7	58.36	+-	0.22
fuse	35.4	0.09232	0.002194	0.16	0.45	2.76	26.67	8.80E-15	98.2	0	0.01	1.15	5.31	5.6	58.12	+-	0.4
Eigg		sanidine		J =	0.00094	+-	2.8E-06	(1 s.d.)	Exp. No.: 3I5072.IHD			Total gas age =			58.73	+-	0.2

2.2	37.45	0.06863	0.00602	0.12	0.26	5.9	7	1.00E-14	95.3	0	0	0.31	7.14	7.9	59.46	+-	0.27
2.6	35.48	0.05125	0.001288	0.06	0.24	2.47	23.07	2.00E-14	98.9	0	0	1.09	9.56	15.1	58.53	+-	0.2
3.1	34.94	0.05155	0.001755	0.18	0.44	6.27	25.77	1.20E-14	98.5	0	0	0.8	9.51	9.5	57.42	+-	0.35
3.5	35.73	0.04932	0.001059	0.09	0.29	2.04	16.63	3.00E-14	99.1	0	0	1.27	9.94	22.9	59.05	+-	0.2
3.8	35.54	0.04441	0.00154	0.2	0.29	5.22	26.65	1.10E-14	98.7	0	0	0.79	11.03	8.8	58.51	+-	0.29
4.2	35	0.05057	0.000258	0.12	0.39	3.23	106.18	1.30E-14	99.8	0	0	5.36	9.69	10.5	58.24	+-	0.27
4.5	35.89	0.04873	0.001584	0.1	0.25	3.01	12.22	2.70E-14	98.7	0	0	0.84	10.06	20.5	59.05	+-	0.19
fuse	35.96	0.06539	0.001205	0.22	0.79	8.57	64.33	6.20E-15	99	0	0	1.48	7.49	4.7	59.36	+-	0.61
Eigg		sanidine		J =	0.00094	+-	2.8E-06	(1 s.d.)		Exp. No.: 3I5140.IHD		Total gas age =			58.2	+-	0.25
1.6	43.67	0.06202	0.02983	1.11	2.06	100	16.74	8.30E-16	79.8	0	0	0.06	7.9	2	58.12	+-	2.93
2.1	38.08	0.06854	0.012195	0.48	0.86	74.89	14.16	2.30E-15	90.6	0	0	0.15	7.15	5.4	57.51	+-	1.03
2.5	35.95	0.0906	0.003347	0.22	0.4	26.97	18.66	6.00E-15	97.3	0	0.01	0.74	5.41	14.2	58.3	+-	0.4
2.9	35.3	0.05201	0.002195	0.11	0.41	18.93	16.1	1.10E-14	98.2	0	0	0.65	9.42	26.8	57.79	+-	0.3
3.3	35.65	0.06693	0.002408	0.12	0.4	15.7	14.84	1.30E-14	98	0	0	0.76	7.32	29.8	58.26	+-	0.3
3.4	36.68	0.05037	0.004492	0.16	0.42	47.52	18.35	6.70E-15	96.4	0	0	0.31	9.73	15.7	58.95	+-	0.48
fuse	35.91	0.06768	0.003578	0.42	0.45	60.67	42.29	2.60E-15	97.1	0	0	0.52	7.24	6.1	58.12	+-	0.81
Eigg		sanidine		J =	0.00094	+-	2.8E-06	(1 s.d.)		Exp. No.: 3I5141.IHD		Total gas age =			58.81	+-	0.2
2.1	38.45	0.13494	0.010013	0.21	0.58	15.84	12.15	5.30E-15	92.3	0	0.01	0.37	3.63	3.6	59.12	+-	0.7
2.5	35.35	0.05663	0.000836	0.09	0.42	14.92	34.93	2.00E-14	99.3	0	0	1.85	8.65	13.4	58.47	+-	0.29
2.9	35.66	0.06792	0.002423	0.1	0.39	10.88	10.67	2.20E-14	98	0	0	0.77	7.21	15.3	58.21	+-	0.27
3.3	35.76	0.05966	0.000998	0.1	0.42	8.54	15.43	2.70E-14	99.2	0	0	1.63	8.21	17.8	59.06	+-	0.27
3.7	35.53	0.06171	0.00114	0.1	0.35	10.82	12.93	2.60E-14	99.1	0	0	1.48	7.94	17.9	58.61	+-	0.22
4.5	36.34	0.07801	0.003043	0.17	0.27	22.31	16.85	7.90E-15	97.5	0	0.01	0.7	6.28	5.3	59.03	+-	0.31
fuse	35.75	0.06316	0.000709	0.1	0.21	6.8	17.33	4.00E-14	99.4	0	0	2.43	7.76	26.7	59.19	+-	0.15
Eigg		sanidine		J =	0.00094	+-	2.8E-06	(1 s.d.)		Exp. No.: 3I5142.IHD		Total gas age =			58.91	+-	0.22
1.2	44.97	0.08842	0.03102	0.33	0.84	42.19	7.47	3.50E-15	79.6	0	0.01	0.08	5.54	4.4	59.85	+-	1.3
2.1	37.04	0.0909	0.007092	0.17	0.25	22.04	13.21	8.00E-15	94.4	0	0.01	0.35	5.39	10.3	58.43	+-	0.49
2.6	36.13	0.06009	0.00285	0.08	0.29	11.91	9.73	2.00E-14	97.7	0	0	0.58	8.15	25.9	58.99	+-	0.22
3	35.84	0.04718	0.001844	0.09	0.3	17.45	19.85	1.90E-14	98.5	0	0	0.7	10.39	23.6	59	+-	0.25
3.4	35.99	0.08115	0.003161	0.21	0.63	20.75	30.45	7.80E-15	97.4	0	0.01	0.7	6.04	9.9	58.61	+-	0.6
fuse	35.79	0.06077	0.001906	0.1	0.32	13.07	12.64	2.00E-14	98.4	0	0	0.87	8.06	25.9	58.89	+-	0.23
Eigg		sanidine		J =	0.00094	+-	2.8E-06	(1 s.d.)		Exp. No.: 3I5143.IHD		Total gas age =			58.63	+-	0.19
2.3	36.56	0.09804	0.004405	0.12	0.32	10.85	12.21	1.20E-14	96.5	0	0.01	0.61	5	8	58.95	+-	0.33
2.9	35.79	0.08817	0.003262	0.17	0.47	15.36	16.55	8.70E-15	97.3	0	0.01	0.74	5.56	5.7	58.25	+-	0.39
3.3	35.46	0.07638	0.002132	0.08	0.44	11.8	13.57	1.60E-14	98.2	0	0.01	0.98	6.41	10.3	58.25	+-	0.29
3.7	35.51	0.08294	0.002194	0.15	0.36	10.69	21.68	1.40E-14	98.2	0	0.01	1.03	5.91	9.2	58.31	+-	0.32
4.1	35.52	0.07147	0.00143	0.07	0.14	5.21	8.4	3.80E-14	98.8	0	0	1.36	6.86	24.9	58.69	+-	0.11
4.5	35.4	0.05934	0.000665	0.06	0.21	5.69	15.81	5.10E-14	99.5	0	0	2.44	8.26	33	58.86	+-	0.14
fuse	36.07	0.08627	0.003891	0.13	0.5	13.01	8.73	1.40E-14	96.8	0	0.01	0.61	5.68	8.9	58.41	+-	0.35
Eigg		sanidine		J =	0.00265	+-	7.9E-06	(1 s.d.)		Exp. No.: 3I5192.IHD		Total gas age =			58.68	+-	0.17
dgs1	16.002	0.09105	0.010568	0.13	0.2	0.71	2.34	1.60E-14	80.5	0	0.01	0.24	5.38	1.9	60.51	+-	0.28
fs1	12.619	0.09517	0.000417	0.07	0.09	0.21	6.4	7.90E-14	99.1	0	0.01	6.23	5.15	9.9	58.74	+-	0.06
fs2	14.347	0.053	0.006375	0.05	0.08	0.63	1.26	4.80E-14	86.9	0	0	0.23	9.25	6	58.57	+-	0.1

fs3	12.486	0.04704	0.000085	0.05	0.12	0.64	72.34	4.90E-14	99.8	0	0	15.08	10.42	6.2	58.56	+-	0.08
fs4	12.669	0.0558	0.00051	0.09	0.08	0.43	6.98	9.30E-14	98.8	0	0	2.99	8.78	11.6	58.83	+-	0.07
fs5	12.707	0.04684	0.000649	0.05	0.09	0.57	5.86	5.90E-14	98.5	0	0	1.97	10.46	7.3	58.81	+-	0.06
dgs2	13.138	0.12644	0.002167	0.06	0.07	0.42	1.9	3.60E-14	95.2	0	0.01	1.59	3.88	4.5	58.76	+-	0.08
tf6	12.724	0.0723	0.001012	0.04	0.12	0.27	2.39	6.10E-14	97.7	0	0.01	1.95	6.78	7.7	58.41	+-	0.09
tf7	12.657	0.04646	0.000599	0.05	0.11	1.02	6.68	4.40E-14	98.6	0	0	2.12	10.55	5.5	58.65	+-	0.09
tf8	12.65	0.02897	0.000547	0.05	0.1	0.75	5.12	5.50E-14	98.7	0	0	1.45	16.91	6.9	58.68	+-	0.08
tf9	12.607	0.04681	0.000579	0.03	0.09	0.49	4.94	5.70E-14	98.7	0	0	2.21	10.47	7.2	58.45	+-	0.07
tf10	12.567	0.03194	0.000227	0.04	0.07	0.95	21.41	5.30E-14	99.5	0	0	3.85	15.34	6.6	58.74	+-	0.08
dgs3	13.462	0.08572	0.003087	0.06	0.09	0.99	3.77	1.30E-14	93.3	0	0.01	0.76	5.72	1.6	58.99	+-	0.17
tf11	12.635	0.03804	0.00056	0.02	0.08	0.34	12.28	5.10E-14	98.7	0	0	1.86	12.88	6.4	58.6	+-	0.11
tf12	12.575	0.05431	0.000532	0.06	0.12	0.6	9.71	3.30E-14	98.8	0	0	2.79	9.02	4.1	58.37	+-	0.1
tf13	12.67	0.09552	0.000594	0.04	0.13	0.53	9.1	3.20E-14	98.7	0	0.01	4.39	5.13	4	58.74	+-	0.11
tf14	12.556	0.06775	0.000443	0.08	0.15	0.74	18.77	2.10E-14	99	0	0	4.18	7.23	2.6	58.4	+-	0.15
Eigg		glass		J =	0.00094	+-	2.8E-06	(1 s.d.)		Exp. No.: 3I5066.IHD		Total gas age =			46.05	+-	0.17
1.7	48.79	0.0495	0.087	0.1	0.17	1.73	0.51	3.00E-14	47.3	0	0	0.02	9.9	17.9	38.67	+-	0.29
1.8	40.87	0.06339	0.04071	0.22	0.41	2.86	1.06	1.40E-14	70.6	0	0	0.04	7.73	6.6	48.19	+-	0.39
2.1	40.35	0.06234	0.03794	0.13	0.37	2.43	1.45	1.30E-14	72.2	0	0	0.04	7.86	6.3	48.68	+-	0.38
2.5	40.36	0.06075	0.037	0.09	0.23	4.49	0.83	1.20E-14	72.9	0	0	0.04	8.07	5.6	49.15	+-	0.23
2.6	40.22	0.05861	0.03807	0.11	0.38	8.39	1.67	9.40E-15	72	0	0	0.04	8.36	4.4	48.41	+-	0.41
2.7	40.36	0.06325	0.03867	0.16	0.73	4.11	2.44	1.60E-14	71.7	0	0	0.04	7.75	7.5	48.34	+-	0.7
3	40.08	0.07135	0.03727	0.16	0.48	4.97	1.6	8.60E-15	72.5	0	0	0.05	6.87	4.1	48.56	+-	0.46
3.7	41.36	0.08716	0.04434	0.09	0.46	3.15	0.96	1.60E-14	68.3	0	0.01	0.05	5.62	7.8	47.23	+-	0.4
4.4	41.25	0.07867	0.04496	0.05	0.2	1.26	0.55	4.10E-14	67.8	0	0.01	0.05	6.23	20.2	46.74	+-	0.2
5	41.4	0.07887	0.04427	0.1	0.25	1.65	1.29	2.00E-14	68.4	0	0.01	0.05	6.21	9.8	47.33	+-	0.34
fuse	41.15	0.07928	0.04384	0.06	0.15	2.42	1.24	2.00E-14	68.5	0	0.01	0.05	6.18	9.8	47.13	+-	0.29
Eigg		glass		J =	0.00094	+-	2.8E-06	(1 s.d.)		Exp. No.: 3I5079.IHD		Total gas age =			48.36	+-	0.18
2	39.75	0.04527	0.04413	0.05	0.15	1.99	0.93	8.20E-14	67.2	0	0	0.03	10.82	31.5	44.66	+-	0.23
2.1	37.19	0.0512	0.02215	0.15	0.36	4.39	3.01	1.70E-14	82.4	0	0	0.06	9.57	5.7	51.16	+-	0.41
2.2	36.86	0.05438	0.019351	0.08	0.24	1.85	1.7	4.70E-14	84.5	0	0	0.08	9.01	15.5	51.98	+-	0.22
2.4	37.06	0.0434	0.0198	0.25	0.38	3.9	3.4	1.60E-14	84.2	0	0	0.06	11.29	5.3	52.09	+-	0.43
2.5	36.88	0.04915	0.0231	0.23	0.32	5.91	3.51	1.20E-14	81.5	0	0	0.06	9.97	4.1	50.2	+-	0.46
2.8	37.41	0.05535	0.02452	0.15	0.4	4.83	2.55	2.00E-14	80.6	0	0	0.06	8.85	6.8	50.37	+-	0.41
3.1	37.9	0.07588	0.02562	0.26	0.81	4.76	5.43	6.50E-15	80	0	0.01	0.08	6.46	2.2	50.64	+-	0.87
3.5	36.91	0.08175	0.02274	0.4	1.16	10.91	16.34	2.80E-15	81.8	0	0.01	0.1	5.99	0.9	50.42	+-	1.96
4.3	37.46	0.10011	0.02929	0.18	0.62	2.33	3.89	9.80E-15	76.9	0	0.01	0.09	4.89	3.5	48.14	+-	0.69
fuse	37.58	0.08467	0.02949	0.07	0.27	1.09	0.99	6.80E-14	76.8	0	0.01	0.08	5.79	24.4	48.24	+-	0.23
SR252		WR.CORE		J =	0.00271	+-	8.1E-06	(1 s.d.)		Exp. No.: 3f0016.IHD		Total gas age =			60.09	+-	0.33
12	717.7	3.293	2.397	0.02	0.54	1.98	0.22	3.00E-14	1.3	0	0.22	0.04	0.148	0.7	46.44	+-	27.36
13	462.9	3.148	1.5185	0.1	0.46	2.04	0.3	4.80E-14	3.1	0	0.21	0.05	0.155	0.7	69.32	+-	15.77
14	162.84	2.354	0.5157	0.11	0.22	0.94	0.4	8.70E-14	6.5	0	0.16	0.12	0.208	1.7	51.34	+-	3.9
15	60.03	1.907	0.16181	0.21	0.14	1.19	0.75	1.50E-13	20.6	0	0.13	0.31	0.257	2.4	59.52	+-	1.86
16	31.53	1.7379	0.06352	0.34	0.17	1.03	1.57	1.80E-13	40.9	0	0.12	0.72	0.282	2.8	62.02	+-	1.48
17	23.35	1.6035	0.03648	0.02	0.05	0.21	0.39	1.80E-13	54.4	0	0.11	1.16	0.305	2.9	61.08	+-	0.23
18	18.377	1.5592	0.02066	0.31	0.1	0.47	2.53	3.20E-13	67.4	0	0.1	1.99	0.314	5.3	59.65	+-	0.76
19	16.535	1.4627	0.014404	0.3	0.1	0.65	3.63	3.60E-13	74.9	0.01	0.1	2.68	0.335	6	59.65	+-	0.74
20	15.512	1.2969	0.010566	0.43	0.13	0.77	5.98	2.70E-13	80.5	0.01	0.09	3.24	0.378	4.4	60.1	+-	0.9
21	15.272	1.1545	0.009418	0.37	0.1	0.75	5.69	3.30E-13	82.4	0.01	0.08	3.24	0.424	5.3	60.51	+-	0.76

22.5	15.638	1.0363	0.010723	0.18	0.07	0.41	2.46	6.70E-13	80.2	0.01	0.07	2.55	0.473	11	60.37	+-	0.38
24	15.582	0.9238	0.010218	0.37	0.11	0.77	5.22	3.20E-13	81.1	0.01	0.06	2.39	0.53	5.2	60.77	+-	0.77
26	18.997	0.9995	0.02215	0.24	0.08	0.77	1.91	4.00E-13	65.9	0	0.07	1.19	0.49	6.6	60.27	+-	0.62
28	19.81	0.9825	0.0246	0.28	0.12	0.62	2.18	3.30E-13	63.7	0	0.07	1.05	0.498	5.4	60.69	+-	0.78
30	16.763	0.8128	0.013335	0.5	0.1	1.23	5.81	2.30E-13	76.9	0.01	0.05	1.61	0.603	3.6	61.95	+-	1.11
33	15.684	0.8036	0.010563	0.35	0.08	0.92	4.77	3.40E-13	80.5	0.01	0.05	2.01	0.609	5.5	60.72	+-	0.72
36	14.952	1.1802	0.007864	0.53	0.4	1.05	9.57	2.30E-13	85.1	0.01	0.08	3.96	0.415	3.7	61.18	+-	1.09
39	13.968	6.785	0.007626	0.46	0.1	0.24	10.01	2.80E-13	87.6	0.01	0.46	23.49	0.072	4.6	59.15	+-	0.86
41	18.257	5.472	0.02162	0.1	0.05	0.13	0.88	9.70E-13	67.3	0	0.37	6.68	0.089	16.1	59.34	+-	0.27
43	18.101	4.317	0.01915	0.46	0.12	0.31	4.3	2.20E-13	70.6	0	0.29	5.95	0.113	3.6	61.59	+-	1.14
47	19.269	3.951	0.02436	0.13	0.07	0.09	1.04	1.10E-13	64.2	0	0.27	4.28	0.124	1.7	59.68	+-	0.37
50	20.22	3.917	0.02727	0.24	0.12	0.14	1.83	5.30E-14	61.6	0	0.26	3.79	0.125	0.9	60.09	+-	0.71
SR215		wr lch		J =	0.00268	+-	8E-06	(1 s.d.)		Exp. No.: 3f0040.IHD		Total gas age =			62.08	+-	0.19
12	29.8	0.3901	0.09972	2.51	10.83	643.28	46.57	1.00E-17	1.2	0	0.03	0.1	1.256	0	1.728	+-	68.173
13.5	22.91	2.978	0.02369	0.28	0.92	6.59	14.81	6.00E-15	70.5	0	0.2	3.32	0.164	0.2	76.45	+-	4.66
15	17.614	2.9	0.008573	0.14	0.25	1.44	8.64	2.90E-14	86.9	0	0.2	8.93	0.169	1.1	72.56	+-	0.93
16.2	15.291	2.477	0.00482	0.03	0.13	0.73	6.97	6.10E-14	91.9	0.01	0.17	13.57	0.197	2.5	66.74	+-	0.4
17.2	14.611	2.196	0.003752	0.1	0.15	1.09	15.31	4.10E-14	93.6	0.01	0.15	15.45	0.223	1.8	64.92	+-	0.67
18.5	13.998	1.9963	0.003072	0.09	0.07	0.65	8.49	8.30E-14	94.6	0.01	0.13	17.16	0.245	3.7	62.91	+-	0.3
19.5	13.71	1.8022	0.002143	0.1	0.16	0.86	15.29	6.60E-14	96.4	0.01	0.12	22.21	0.272	2.9	62.78	+-	0.36
20.5	13.524	2.047	0.002395	0.02	0.06	0.43	5.5	1.80E-13	95.9	0.01	0.14	22.56	0.239	8.3	61.66	+-	0.15
21.2	13.236	2.248	0.001858	0.06	0.09	0.53	15.25	8.50E-14	97.2	0.01	0.15	31.94	0.218	3.8	61.14	+-	0.27
21.9	13.206	2.683	0.002155	0.1	0.14	0.51	7.96	1.50E-13	96.8	0.01	0.18	32.86	0.182	6.8	60.76	+-	0.19
22.6	13.109	3.091	0.001938	0.13	0.14	0.29	6.65	2.30E-13	97.5	0.01	0.21	42.1	0.158	10.7	60.77	+-	0.16
23.3	13.006	3.116	0.001827	0.11	0.11	0.29	12.41	1.40E-13	97.7	0.01	0.21	45.02	0.157	6.2	60.45	+-	0.19
24	12.967	3.106	0.001733	0.09	0.09	0.25	13.82	1.30E-13	97.9	0.01	0.21	47.3	0.157	6	60.39	+-	0.19
25	12.939	3.02	0.002103	0.03	0.14	0.33	10.6	1.10E-13	97	0.01	0.2	37.91	0.162	5.3	59.72	+-	0.21
26.2	13.092	3.151	0.002116	0.04	0.04	0.31	8.43	1.60E-13	97.1	0.01	0.21	39.32	0.155	7.1	60.47	+-	0.15
27.4	13.169	3.449	0.002247	0.04	0.07	0.28	7.81	1.70E-13	97	0.01	0.23	40.52	0.142	7.6	60.77	+-	0.15
28.5	13.336	4.069	0.003057	0.04	0.07	0.27	8.38	1.00E-13	95.6	0.01	0.27	35.14	0.12	4.7	60.68	+-	0.23
30	13.535	4.993	0.003377	0.05	0.11	0.33	11.37	7.30E-14	95.5	0.01	0.34	39.03	0.098	3.3	61.55	+-	0.33
33	13.942	5.93	0.003758	0.03	0.08	0.21	5.26	1.50E-13	95.3	0.01	0.4	41.66	0.082	6.5	63.31	+-	0.17
37	15.214	6.29	0.005917	0.05	0.07	0.27	3.7	1.20E-13	91.7	0.01	0.42	28.07	0.078	4.8	66.42	+-	0.22
43	16.398	62.09	0.02567	0.06	0.14	0.05	1.81	1.20E-13	83.3	0.01	4.18	63.87	0.0076	5.1	67.52	+-	0.28
50	15.907	147.82	0.0529	0.07	0.18	0.11	4.42	3.30E-14	74.2	0.01	9.95	73.77	0.003	1.5	62.21	+-	0.95

(a) Steps labeled either as temperature (deg C), laser power (W),or individual total fusion analyses (TF#).

(b) Corrected for 37Ar and 39Ar decay, half-lives 35.1 days and 259 years, respectively.

(c) Radiogenic (R), calcium-derived (Ca), and potassium-derived (K) argon, respectively (percent).

(d) Ages calculated relative to 85G003 TCR Sanidine at 27.92 Ma with lambda e = 0.581E-10/yr and lambda b = 4.692E-10/yr.

Results table for Skye

Step (a)	40Ar/39Ar (b)	37Ar/39Ar (b)	36Ar/39Ar (b)	40Ar s.d. (%)	39Ar s.d. (%)	37Ar s.d. (%)	36Ar s.d. (%)	40ArR (mol)
SK137		wr core		J =	0.00271	+-	8.1E-06	(1 s.d.)
12	76.03	1.1542	0.2159	0.04	0.13	3.27	1.15	4.60E-14
13	66.31	0.9546	0.17283	0.08	0.5	19.55	7.04	1.10E-14
14	87.07	0.9005	0.2433	0.06	0.29	12.3	2.98	1.90E-14
15	384.3	0.8773	1.2621	0.04	0.59	27.16	1.24	4.70E-14
16	441.3	0.7309	1.4663	0.03	0.5	23.29	0.97	4.40E-14
17	301	0.6024	0.9691	0.07	0.41	28.8	1.18	1.20E-14
18	167.18	0.6521	0.5138	0.05	0.33	17.4	1.44	1.90E-14
19	132.26	0.4772	0.3936	0.06	0.53	47.39	3.73	6.90E-14
20	111.84	0.6212	0.3287	0.05	0.22	12.85	1.59	1.80E-13
20.6	102.86	0.6349	0.2988	0.05	0.22	13.32	1.85	1.70E-13
21	89.5	0.6155	0.2515	0.07	0.43	26.06	4.13	9.30E-14
22	83.5	0.7132	0.2366	0.1	0.14	5.73	1.12	3.30E-13
23	67.86	0.783	0.18343	0.06	0.2	7.98	2.22	2.20E-13
dynm	52.25	0.8608	0.1304	0.06	0.19	7.77	3.33	2.00E-13
26	40.15	0.966	0.08889	0.13	0.22	4.17	2.88	3.50E-13
28	30.33	0.9854	0.05813	0.07	0.17	3.67	4.02	3.60E-13
32	20.36	0.9188	0.02558	0.07	0.11	1.88	4.34	7.50E-13
37	16.474	1.6551	0.012703	0.07	0.12	1.28	11	6.10E-13
47	25.56	3.931	0.04491	0.18	0.25	0.49	2.03	2.60E-12
50	30.67	4.849	0.05441	0.09	0.49	3.25	18.35	1.40E-14
SK167		wr core felsic		J =	0.00271	+-	8.1E-06	(1 s.d.)
12	14.457	0.2198	0.010356	0.02	0.06	0.43	0.4	2.80E-13
13.5	13.858	0.19772	0.002235	0.03	0.07	0.61	2.79	1.60E-13
15	13.235	0.16868	0.000583	0.01	0.03	0.41	4.57	6.60E-13
16	13	0.15166	0.000545	0.02	0.04	1.85	25.84	5.00E-13
17	12.756	0.14347	0.000217	0.02	0.04	0.88	39.88	1.10E-12
18	12.594	0.12778	0.000142	0.01	0.05	1.26	47.16	1.30E-12
19	12.526	0.11816	0.00009	0.02	0.02	0.92	78.41	1.40E-12
20	12.412	0.10695	0.000078	0.01	0.05	0.42	44.19	6.40E-13
20.6	12.408	0.10308	0.000114	0.03	0.05	0.64	25.36	6.30E-13
21	12.405	0.07139	0.000022	0.02	0.03	0.78	691.52	2.30E-13
22	12.422	0.06148	0.000052	0.05	0.05	3.04	148.44	6.70E-13
23.2	12.436	0.07157	0.000143	0.12	0.06	1.06	22.98	4.50E-13
25	12.435	0.10329	0.000178	0.02	0.06	1.9	60.81	6.30E-13
28	12.266	0.2801	0.000588	0.03	0.07	0.73	27.98	3.90E-13
32	12.158	0.567	0.00067	0.02	0.06	0.45	22.4	5.60E-13

Step (a)	40ArR (c)	40ArK (c)	39ArCa (c)	36ArCa (c)	K/Ca (%)	39Ar (%)	Apparent Age (Ma)	+-	1 s.d. (Ma)
SK137		Exp. No.:	F0015.IHD	Total gas age =			62.69	+-	0.93
12	16.2	0	0.08	0.14	0.424	0.8	59.3	+-	3.46
13	23.1	0	0.06	0.15	0.513	0.2	73.38	+-	16.58
14	17.5	0	0.06	0.1	0.544	0.3	73.1	+-	9.94
15	3	0	0.06	0.02	0.558	0.9	54.92	+-	26.13
16	1.8	0	0.05	0.01	0.67	1.2	39.03	+-	24.81
17	4.9	0	0.04	0.02	0.813	0.2	70.45	+-	17.65
18	9.2	0	0.04	0.03	0.751	0.3	73.83	+-	10.66
19	12.1	0	0.03	0.03	1.026	0.9	76.59	+-	20.33
20	13.2	0	0.04	0.05	0.788	2.6	70.78	+-	7.28
20.6	14.2	0	0.04	0.06	0.771	2.5	70.15	+-	7.63
21	17	0	0.04	0.06	0.796	1.3	73.01	+-	14.25
22	16.3	0	0.05	0.08	0.687	5.2	65.43	+-	3.74
23	20.2	0	0.05	0.11	0.625	3.4	65.86	+-	5.6
dynm	26.4	0	0.06	0.17	0.569	3.1	66.22	+-	5.94
26	34.8	0	0.07	0.29	0.507	5.4	67.01	+-	3.52
28	43.6	0	0.07	0.45	0.497	5.9	63.59	+-	3.18
32	63.2	0	0.06	0.95	0.533	12.4	61.89	+-	1.5
37	78	0.01	0.11	3.44	0.296	10.1	61.81	+-	1.84
47	49.3	0	0.26	2.31	0.124	43.4	60.7	+-	1.28
50	48.8	0	0.33	2.35	0.101	0.2	71.99	+-	13.27
SK167		Exp. No.:	F0012.IHD	Total gas age =			59.81	+-	0.18
12	78.9	0.01	0.01	0.56	2.23	2.9	54.95	+-	0.08
13.5	95.3	0.01	0.01	2.34	2.48	1.4	63.46	+-	0.1
15	98.8	0.01	0.01	7.64	2.9	6	62.81	+-	0.05
16	98.8	0.01	0.01	7.35	3.23	4.5	61.75	+-	0.18
17	99.6	0.01	0.01	17.48	3.42	9.9	61.05	+-	0.1
18	99.7	0.01	0.01	23.71	3.83	12.3	60.38	+-	0.08
19	99.9	0.01	0.01	34.79	4.15	12.9	60.13	+-	0.07
20	99.9	0.01	0.01	36.29	4.58	6.1	59.6	+-	0.05
20.6	99.8	0.01	0.01	23.78	4.75	6	59.53	+-	0.05
21	%100.0	0.01	0	85.18	6.86	2.1	59.63	+-	0.05
22	99.9	0.01	0	30.94	7.97	6.3	59.67	+-	0.09
23.2	99.7	0.01	0	13.24	6.85	4.2	59.61	+-	0.09
25	99.6	0.01	0.01	15.34	4.74	5.9	59.57	+-	0.13
28	98.8	0.01	0.02	12.57	1.749	3.8	58.27	+-	0.2
32	98.7	0.01	0.04	22.33	0.864	5.5	57.76	+-	0.17

37	12.803	1.5509	0.003258	0.03	0.04	0.19	1.63	3.10E-13	93.4	0.01	0.1	12.57	0.316	3	57.59	+-	0.08
43	12.755	1.9885	0.002887	0.02	0.06	0.39	4.91	5.50E-13	94.5	0.01	0.13	18.18	0.246	5.3	58.06	+-	0.17
50	13.032	0.8496	0.002847	0.01	0.03	0.32	1.61	2.00E-13	94	0.01	0.06	7.88	0.576	1.9	58.97	+-	0.07
SK139		wr lch		J =	0.00269	+-	8.1E-06	(1 s.d.)		Exp. No.: F0033.IHD		Total gas age =			60.93	+-	0.21
12	20.28	0.9327	0.01263	0.41	0.27	3.22	11.58	2.20E-14	82	0	0.06	1.95	0.525	0.4	78.91	+-	1.98
13	18.566	0.9478	0.013226	1.15	0.5	8.43	29.71	7.20E-15	79.3	0	0.06	1.89	0.517	0.2	70.1	+-	5.3
14.5	16.655	0.9084	0.006278	0.22	0.12	1.29	9.06	5.10E-14	89.3	0.01	0.06	3.82	0.539	1.1	70.75	+-	0.76
16	14.652	0.9841	0.003218	0.13	0.07	0.4	4.86	1.80E-13	94	0.01	0.07	8.07	0.498	4.2	65.64	+-	0.22
17	13.927	0.9202	0.002713	0.22	0.16	0.62	9.86	1.00E-13	94.8	0.01	0.06	8.96	0.532	2.5	62.92	+-	0.37
18.2	13.517	0.8002	0.001883	0.11	0.1	0.28	6.14	2.40E-13	96.3	0.01	0.05	11.22	0.612	6	62.1	+-	0.17
19.2	12.967	0.7246	0.001579	0.18	0.12	0.9	23.8	4.50E-13	96.8	0.01	0.05	12.11	0.676	11.4	59.91	+-	0.47
20.8	12.839	0.6789	0.00114	0.17	0.1	0.37	10.74	2.40E-13	97.8	0.01	0.05	15.73	0.721	6.2	59.9	+-	0.19
21.6	12.727	0.7337	0.000914	0.2	0.15	1.04	49.17	4.10E-13	98.3	0.01	0.05	21.2	0.668	10.5	59.71	+-	0.5
22.5	12.656	0.7839	0.000541	0.2	0.13	0.94	103.22	4.40E-13	99.2	0.01	0.05	38.25	0.625	11.2	59.91	+-	0.49
23.5	12.695	0.9294	0.000637	0.18	0.17	0.84	84.4	4.50E-13	99.1	0.01	0.06	38.55	0.527	11.4	60.03	+-	0.47
24.5	12.851	1.1564	0.001406	0.13	0.06	0.31	10.98	2.00E-13	97.5	0.01	0.08	21.71	0.423	5.2	59.78	+-	0.19
25.7	12.847	1.4473	0.001345	0.2	0.14	0.38	11.18	2.20E-13	97.8	0.01	0.1	28.4	0.338	5.7	59.96	+-	0.21
27	12.986	1.9598	0.001925	0.17	0.1	0.34	7.07	2.40E-13	96.8	0.01	0.13	26.88	0.25	6.2	60.02	+-	0.18
28.5	13.232	2.907	0.002306	0.19	0.13	0.38	10.12	1.60E-13	96.6	0.01	0.2	33.27	0.168	3.9	61.03	+-	0.26
30	13.51	4.309	0.003339	0.15	0.12	0.16	7.89	1.40E-13	95.2	0.01	0.29	34.06	0.113	3.5	61.47	+-	0.27
34	13.722	5.491	0.004121	0.16	0.17	0.28	5.66	1.70E-13	94.2	0.01	0.37	35.17	0.089	4.2	61.87	+-	0.26
39	14.18	7.02	0.005557	0.16	0.2	0.32	3.81	1.90E-13	92.3	0.01	0.47	33.35	0.069	4.7	62.65	+-	0.26
43	18.335	76.74	0.03938	0.22	0.28	0.28	3.19	4.20E-14	69.2	0	5.16	51.45	0.0061	1	63.73	+-	0.95
50	14.41	50.7	0.018897	0.42	0.31	0.28	18.17	2.50E-14	88.7	0.01	3.41	70.84	0.0093	0.6	63.05	+-	1.45
SB10		wr lch		J =	0.00268	+-	0.000008	(1 s.d.)		Exp. No.: F0041.IHD		Total gas age =			61.31	+-	0.19
12	20.11	1.4267	0.003933	0.21	0.7	14.66	75.31	5.20E-15	94.8	0	0.1	9.58	0.343	0.1	89.92	+-	3.62
13.5	18.791	1.496	0.005416	0.17	0.16	1.89	6.47	3.50E-14	92.1	0	0.1	7.29	0.327	0.6	81.84	+-	0.48
15	15.95	1.3705	0.003078	0.06	0.11	0.47	1.91	2.00E-13	95	0.01	0.09	11.75	0.357	3.9	71.82	+-	0.12
16	14.489	1.2171	0.001786	0.08	0.09	0.55	2.89	2.40E-13	97	0.01	0.08	17.99	0.402	5	66.73	+-	0.1
16.7	13.926	1.1136	0.001466	0.14	0.14	0.42	5.74	1.80E-13	97.5	0.01	0.07	20.05	0.44	3.9	64.51	+-	0.16
17.4	13.252	1.0399	0.000536	0.06	0.11	1.07	54.48	4.00E-13	99.4	0.01	0.07	51.24	0.471	9.2	62.62	+-	0.21
17.5	12.893	1.0539	0.000184	0.1	0.08	1.32	%-186.79	3.00E-13	%100.2	0.01	0.07	151.27	0.465	6.9	61.43	+-	0.25
18	13.005	1.0037	0.00064	0.08	0.13	3.03	110.58	2.40E-14	99.1	0.01	0.07	41.4	0.488	0.6	61.3	+-	0.57
18.5	12.984	1.0704	0.000899	0.04	0.14	0.85	15.61	9.70E-14	98.6	0.01	0.07	31.42	0.457	2.3	60.87	+-	0.16
19	13.011	1.1369	0.00106	0.1	0.09	0.77	9.69	1.20E-13	98.3	0.01	0.08	28.31	0.431	2.8	60.8	+-	0.13
19.5	12.989	1.2222	0.001185	0.14	0.19	0.65	7.62	1.40E-13	98	0.01	0.08	27.23	0.401	3.3	60.56	+-	0.17
20	12.845	1.2428	0.000912	0.13	0.09	0.86	18.97	8.80E-14	98.6	0.01	0.08	35.96	0.394	2.1	60.27	+-	0.18
21	13.005	1.3949	0.001561	0.03	0.08	0.45	3.12	2.40E-13	97.3	0.01	0.09	23.59	0.351	5.8	60.19	+-	0.08
21.5	12.832	1.444	0.001267	0.08	0.15	0.47	6.3	1.80E-13	98	0.01	0.1	30.08	0.339	4.4	59.8	+-	0.13
22	12.798	1.5839	0.00082	0.09	0.13	0.82	28.29	4.70E-13	99.1	0.01	0.11	50.99	0.309	11.1	60.32	+-	0.18
22.5	12.864	1.6534	0.001096	0.08	0.11	0.86	22.96	6.40E-14	98.5	0.01	0.11	39.82	0.296	1.5	60.27	+-	0.22
23.5	12.899	1.6975	0.00074	0.07	0.18	0.94	58.08	5.60E-14	99.3	0.01	0.11	60.53	0.288	1.3	60.95	+-	0.26
25	13.141	1.847	0.001789	0.06	0.12	0.56	5.92	1.20E-13	97.1	0.01	0.12	27.25	0.265	2.8	60.69	+-	0.14

27	13.104	1.9989	0.001842	0.08	0.14	0.23	2.42	3.90E-13	97	0.01	0.13	28.65	0.245	9.3	60.5	+-	0.11
29	13.28	1.8706	0.002648	0.07	0.2	1.07	8.68	4.50E-14	95.2	0.01	0.13	18.65	0.262	1.1	60.16	+-	0.29
32	13.268	1.7913	0.003081	0.06	0.06	0.3	1.53	2.50E-13	94.2	0.01	0.12	15.35	0.273	5.9	59.47	+-	0.08
36	12.791	2.472	0.003068	0.08	0.04	0.24	2.68	2.50E-13	94.4	0.01	0.17	21.27	0.198	6.2	57.53	+-	0.11
42	12.697	15.798	0.006617	0.16	0.16	0.27	2.52	2.70E-13	94.3	0.01	1.06	63.03	0.031	6.8	57.56	+-	0.16
50	13.111	13.862	0.006104	0.04	0.18	0.21	2.76	1.30E-13	94.5	0.01	0.93	59.95	0.035	3.1	59.44	+-	0.15
SB3		wr lch		J =	0.00268	+-	0.000008	(1 s.d.)		Exp. No.: F0031.IHD		Total gas age =			59.7	+-	0.19
12	28.35	0.7614	0.0791	7.02	3.75	128.1	26.1	2.60E-16	17.8	0	0.05	0.25	0.643	0	24.23	+-	30.6
13.5	15.582	0.211	0.003006	0.19	0.09	6.53	10.05	5.50E-14	94.4	0.01	0.01	1.85	2.32	0.5	69.81	+-	0.43
15	13.563	0.18544	0.000007	0.18	0.13	5.86	%-579.16	6.40E-14	%100.1	0.01	0.01	701.95	2.64	0.6	64.52	+-	0.36
16	12.964	0.19373	0.000111	0.12	0.09	3.56	237.54	6.10E-13	99.9	0.01	0.01	45.93	2.53	5.9	61.58	+-	0.22
17	12.83	0.18234	0.00049	0.12	0.1	3.77	34.38	5.90E-13	99	0.01	0.01	9.83	2.69	5.8	60.42	+-	0.23
18	12.674	0.16668	-0.000158	0.1	0.07	3.81	-71.66	6.30E-13	%100.5	0.01	0.01	-27.93	2.94	6.2	60.58	+-	0.21
19	12.631	0.15498	0.000127	0.07	0.04	2.59	100.12	1.00E-12	99.8	0.01	0.01	32.23	3.16	10	59.99	+-	0.13
19.7	12.509	0.16915	-0.000066	0.1	0.06	3.09	%-112.03	7.30E-13	%100.3	0.01	0.01	-67.23	2.9	7.3	59.68	+-	0.18
20.4	12.547	0.15371	0.000441	0.06	0.08	1.69	15.56	2.60E-13	99	0.01	0.01	9.2	3.19	2.6	59.15	+-	0.11
21.4	12.479	0.15931	0.000355	0.07	0.04	2.35	26.92	1.10E-12	99.3	0.01	0.01	11.85	3.08	10.8	58.96	+-	0.13
22.1	12.465	0.15893	0.000038	0.08	0.09	2.36	%-1854.33	1.10E-12	%100.0	0.01	0.01	111.39	3.08	10.6	59.33	+-	0.13
22.6	12.408	0.16557	-0.000144	0.08	0.07	3.21	-59.83	7.70E-13	%100.4	0.01	0.01	-30.39	2.96	7.7	59.32	+-	0.17
23.4	12.354	0.1638	0.000054	0.12	0.08	4.3	510.48	5.60E-13	%100.0	0.01	0.01	79.91	2.99	5.6	58.79	+-	0.12
25	12.649	0.15708	0.000323	0.08	0.11	2.98	35.64	1.50E-13	99.3	0.01	0.01	12.83	3.12	1.4	59.8	+-	0.16
26	12.617	0.17069	0.000552	0.12	0.06	4.01	30.73	9.30E-14	98.8	0.01	0.01	8.16	2.87	0.9	59.34	+-	0.23
24.1	12.493	0.15337	0.000104	0.07	0.05	1.23	83.84	1.50E-12	99.8	0.01	0.01	38.86	3.19	15.4	59.37	+-	0.09
27	12.645	0.17319	0.000187	0.08	0.08	2.86	71.18	1.30E-13	99.7	0.01	0.01	24.43	2.83	1.3	59.97	+-	0.15
28.5	12.677	0.2033	0.000357	0.07	0.07	1.96	28.35	1.60E-13	99.3	0.01	0.01	15.02	2.41	1.6	59.9	+-	0.13
30.5	12.705	0.2318	0.000808	0.05	0.08	1.3	8.79	2.20E-13	98.3	0.01	0.02	7.57	2.11	2.2	59.42	+-	0.11
34	12.417	0.5143	0.000645	0.05	0.05	0.6	11.12	2.40E-13	98.8	0.01	0.03	21.06	0.952	2.5	58.41	+-	0.09
38	14.163	4.483	0.008588	11.48	2.2	7.57	31.09	6.90E-14	84.5	0.01	0.3	13.78	0.109	0.7	57.2	+-	8.38
43	14.269	16.981	0.010526	0.89	1.3	1.56	21.35	1.30E-14	87.5	0.01	1.14	42.59	0.029	0.1	60.08	+-	2.06
50	14.128	12.155	0.006541	0.56	0.46	0.48	21.39	2.00E-14	93	0.01	0.82	49.06	0.04	0.2	63	+-	1.08
SD3		wr lch		J =	0.00267	+-	0.000008	(1 s.d.)		Exp. No.: F0030.IHD		Total gas age =			60.07	+-	0.19
12	18.212	0.3555	0.009351	0.59	0.26	11.53	13.78	1.60E-14	85	0	0.02	1	1.378	0.2	73.11	+-	1.79
13	17.523	0.3869	0.007832	0.54	0.18	10.46	15.59	1.70E-14	87	0	0.03	1.3	1.266	0.3	72.01	+-	1.68
14.2	15.403	0.3514	0.002877	0.14	0.11	1.92	6.82	9.70E-14	94.7	0.01	0.02	3.22	1.394	1.5	68.96	+-	0.29
15.5	14.297	0.3271	0.001902	0.08	0.11	1.36	6.49	1.50E-13	96.2	0.01	0.02	4.54	1.498	2.5	65.15	+-	0.18
16.5	14.047	0.3054	0.001439	0.08	0.05	1.13	7.01	1.90E-13	97.1	0.01	0.02	5.6	1.604	3.2	64.61	+-	0.15
17.5	13.847	0.2953	0.001537	0.09	0.08	1.5	8.72	1.40E-13	96.9	0.01	0.02	5.07	1.659	2.3	63.55	+-	0.19
18.5	13.59	0.2613	0.001091	0.05	0.07	1.41	15.72	3.10E-13	97.8	0.01	0.02	6.32	1.875	5.3	62.95	+-	0.22
19.5	13.097	0.3082	0.000977	0.16	0.15	2.47	25.94	4.30E-13	98	0.01	0.02	8.33	1.589	7.5	60.83	+-	0.34
20.5	13.089	0.2513	0.000707	0.1	0.11	1.73	18.89	1.50E-13	98.5	0.01	0.02	9.39	1.949	2.7	61.14	+-	0.19
21.5	13.019	0.2788	0.000791	0.16	0.17	1.77	19.89	6.90E-13	98.4	0.01	0.02	9.31	1.757	12.2	60.71	+-	0.24
22.5	12.727	0.2586	0.000432	0.1	0.08	2.17	39.49	7.30E-13	99.1	0.01	0.02	15.82	1.894	13.2	59.83	+-	0.21
23.2	12.556	0.2668	0.000309	0.14	0.15	2.24	76.49	5.70E-13	99.4	0.01	0.02	22.77	1.836	10.3	59.21	+-	0.27

24	12.48	0.2987	0.000715	0.15	0.06	2.69	35.85	4.20E-13	98.5	0.01	0.02	11.03	1.64	7.6	58.31	+-	0.32
25	12.713	0.276	0.000848	0.06	0.05	1.23	19.13	3.20E-13	98.2	0.01	0.02	8.59	1.775	5.9	59.2	+-	0.21
26	12.675	0.314	0.000826	0.03	0.05	1.05	18.83	3.40E-13	98.3	0.01	0.02	10.04	1.56	6.2	59.07	+-	0.19
27	12.754	0.3795	0.001066	0.06	0.09	0.78	7.25	2.40E-13	97.8	0.01	0.03	9.4	1.291	4.4	59.14	+-	0.12
28	12.873	0.438	0.001634	0.09	0.04	0.89	6.39	1.80E-13	96.5	0.01	0.03	7.08	1.118	3.2	58.93	+-	0.15
29.2	12.811	0.4571	0.001824	0.08	0.09	1.2	7.13	1.40E-13	96.1	0.01	0.03	6.62	1.072	2.6	58.39	+-	0.18
30.5	12.591	0.5117	0.001879	0.16	0.09	1.51	13.77	6.60E-14	95.9	0.01	0.03	7.19	0.957	1.2	57.3	+-	0.34
34	12.22	0.8017	0.001986	0.08	0.07	0.5	5.21	1.60E-13	95.7	0.01	0.05	10.66	0.611	3.2	55.54	+-	0.14
38	12.805	2.877	0.004458	0.07	0.05	0.25	2.33	1.80E-13	91.5	0.01	0.19	17.04	0.17	3.4	55.69	+-	0.13
43	13.851	4.669	0.010488	0.63	0.16	0.94	11.43	1.30E-14	80.2	0.01	0.31	11.75	0.105	0.3	52.96	+-	1.49
50	13.378	4.636	0.006297	0.24	0.12	0.43	7.44	4.00E-14	88.8	0.01	0.31	19.44	0.105	0.8	56.54	+-	0.54
SD1		WR LCH		J =	0.00269	+-	8.1E-06	(1 s.d.)		Exp. No.:	F0032.IHD	Total gas age =			60.21	+-	0.19
12	21.81	0.3984	0.02473	1.1	0.76	26.92	15.66	6.30E-15	66.6	0	0.03	0.43	1.229	0.1	69.08	+-	5.36
13	19.379	0.3499	0.012188	0.29	0.21	7.17	7.09	3.10E-14	81.6	0	0.02	0.76	1.4	0.2	74.99	+-	1.2
14.5	16.799	0.3255	0.004888	0.11	0.09	1.17	2.82	1.90E-13	91.5	0.01	0.02	1.76	1.505	1.5	73.01	+-	0.22
16	14.958	0.2911	0.00182	0.16	0.11	3.5	19.7	4.30E-13	96.6	0.01	0.02	4.22	1.683	3.7	68.64	+-	0.48
17	14.056	0.2432	0.001038	0.16	0.08	2.92	25.61	5.90E-13	97.9	0.01	0.02	6.18	2.01	5.3	65.49	+-	0.36
18	13.424	0.2493	0.000736	0.2	0.12	4.51	56.45	3.70E-13	98.5	0.01	0.02	8.95	1.965	3.5	62.96	+-	0.53
19	13.121	0.229	0.00082	0.14	0.14	2.27	22.17	7.80E-13	98.3	0.01	0.02	7.38	2.14	7.6	61.41	+-	0.26
20	12.769	0.2273	0.000674	0.15	0.13	2.39	27.82	7.70E-13	98.6	0.01	0.02	8.91	2.16	7.7	59.97	+-	0.26
21	12.63	0.2218	0.000751	0.14	0.08	2.62	29.91	6.20E-13	98.4	0.01	0.01	7.79	2.21	6.2	59.21	+-	0.3
22	12.502	0.2373	0.000372	0.18	0.16	3.22	80.6	5.00E-13	99.3	0.01	0.02	16.83	2.06	5	59.14	+-	0.37
23	12.565	0.2664	0.00047	0.13	0.12	0.69	14.15	2.50E-12	99.1	0.01	0.02	14.97	1.839	25.1	59.31	+-	0.13
23.7	12.666	0.3246	0.001131	0.19	0.12	1.47	14.06	1.50E-13	97.6	0.01	0.02	7.58	1.509	1.5	58.89	+-	0.24
24.5	12.616	0.3343	0.000853	0.13	0.08	1.06	16.12	1.70E-13	98.2	0.01	0.02	10.35	1.465	1.7	59.04	+-	0.19
25.5	12.597	0.3639	0.000812	0.14	0.1	0.8	13.95	2.10E-13	98.3	0.01	0.02	11.83	1.346	2.2	59.03	+-	0.17
26.5	12.45	0.4827	0.000652	0.24	0.15	3.13	86.41	2.80E-13	98.7	0.01	0.03	19.53	1.015	2.9	58.6	+-	0.64
27.7	12.526	0.4584	0.000708	0.16	0.11	1.62	42.27	5.10E-13	98.6	0.01	0.03	17.09	1.069	5.2	58.88	+-	0.36
28.7	12.714	0.432	0.001068	0.11	0.05	0.65	9.89	2.30E-13	97.8	0.01	0.03	10.68	1.134	2.3	59.25	+-	0.15
30	12.658	0.4296	0.001277	0.15	0.15	0.78	7.86	2.40E-13	97.3	0.01	0.03	8.88	1.14	2.4	58.69	+-	0.18
35	12.609	0.5231	0.00164	0.13	0.11	0.85	9.51	8.60E-13	96.5	0.01	0.04	8.42	0.936	8.8	58	+-	0.22
40	12.711	1.7517	0.003327	0.16	0.13	0.54	8.32	5.10E-13	93.3	0.01	0.12	13.9	0.279	5.4	56.63	+-	0.35
48	13.633	3.481	0.005797	0.15	0.13	0.28	2.62	1.60E-13	89.4	0.01	0.23	15.85	0.14	1.7	58.24	+-	0.22
SG 59		Riebeckite		J =	0.00095	+-	2.8E-06	(1 s.d.)		Exp. No.:	L5061.IHD	Total gas age =			57.08	+-	0.57
Rudha Stac granite																	
1.9	50.49	0.5041	0.06101	0.32	0.37	2.19	2.61	2.40E-15	64.4	0	0.04	0.23	0.972	27.6	54.74	+-	0.9
2.2	41.6	0.4304	0.02428	0.34	0.62	2.53	5.06	4.40E-15	82.8	0	0.03	0.48	1.138	48	58	+-	0.78
fuse	47.01	0.4036	0.04276	0.34	0.87	3.81	4.62	2.20E-15	73.2	0	0.03	0.26	1.214	24.4	57.9	+-	1.24
SG 59		Riebeckite		J =	0.00095	+-	2.8E-06	(1 s.d.)		Exp. No.:	L5062.IHD	Total gas age =			57.14	+-	0.2
Rudha Stac granite																	
dgs1	86.62	0.7814	0.18028	0.1	0.37	1.34	1.31	5.00E-15	38.6	0	0.05	0.12	0.627	3.2	56.11	+-	1.34
dgs2	43.3	0.7468	0.02996	0.03	0.19	0.49	1.55	2.90E-14	79.7	0	0.05	0.68	0.656	17.8	57.92	+-	0.27
fs1	36.87	0.6457	0.009511	0.17	0.36	0.46	4.41	2.00E-14	92.5	0	0.05	1.85	0.758	12.3	57.26	+-	0.32

fs2	40.11	0.5201	0.019887	0.15	0.27	0.59	2.11	2.20E-14	85.5	0	0.04	0.71	0.942	13.5	57.53	+-	0.29
fs3	36.2	0.9687	0.007011	0.13	0.26	0.38	2.84	2.40E-14	94.5	0	0.07	3.77	0.505	15	57.43	+-	0.2
fs4	34.67	0.3016	0.005597	0.17	0.27	0.51	4.83	2.40E-14	95.3	0	0.02	1.47	1.624	15.4	55.48	+-	0.23
fs5	36.65	0.5469	0.00936	0.1	0.35	0.86	4.68	1.20E-14	92.6	0	0.04	1.6	0.896	7.5	56.95	+-	0.31
fs6	38.23	0.6833	0.015647	0.2	0.48	1.08	6.16	6.40E-15	88	0	0.05	1.19	0.717	4.1	56.51	+-	0.58
fs7	44.05	1.0729	0.03393	0.35	0.69	1.78	4.04	3.20E-15	77.4	0	0.07	0.86	0.456	2	57.27	+-	0.89
tf8	38.96	0.5318	0.014979	0.11	0.33	0.47	3.84	1.50E-14	88.7	0	0.04	0.97	0.921	9.1	58.02	+-	0.36
SG19		hornblende		J =	0.00093	+-	4.7E-06	(1 s.d.)		Exp. No.:	L5094.IHD	Total gas age =			56.9	+-	0.88
Bheinn More granite																	
DGS	78.75	1.6105	0.14127	0.08	0.61	1.45	2.26	6.70E-15	47.2	0	0.11	0.31	0.304	35.9	61.55	+-	1.79
fs19	59.84	6.253	0.0882	0.24	0.94	0.77	7.66	1.80E-15	57.3	0	0.44	1.94	0.078	10.7	57.07	+-	3.38
fs20	40.79	2.737	0.02937	0.27	0.59	0.79	4.17	8.60E-15	79.3	0	0.19	2.54	0.179	53.4	53.74	+-	0.73
SG19		Hornblende		J =	0.00093	+-	4.7E-06	(1 s.d.)		Exp. No.:	L5098.IHD	Total gas age =			56.48	+-	0.36
Bheinn More granite																	
dgs2	63.32	0.6055	0.10045	0.07	0.14	0.85	0.96	3.20E-14	53.2	0	0.04	0.16	0.809	33.2	55.88	+-	0.5
fs22	72.13	4.922	0.12134	0.39	1.6	1.7	6.02	1.40E-15	50.8	0	0.34	1.11	0.099	1.4	60.93	+-	4.11
fs23	54.21	3.596	0.05811	0.15	0.29	1.21	4.67	5.70E-15	68.9	0	0.25	1.69	0.136	5.4	61.94	+-	1.32
fs24	36.54	1.3166	0.010682	0.06	0.13	0.4	2.79	4.30E-14	91.7	0	0.09	3.36	0.372	45	55.59	+-	0.17
fs25	43.43	2.642	0.02806	0.3	0.52	1.87	8.81	4.20E-15	81.4	0	0.18	2.57	0.185	4.2	58.67	+-	1.24
fs26	44.98	1.21	0.03445	0.14	0.5	1.38	3.06	1.10E-14	77.6	0	0.08	0.96	0.405	10.9	57.88	+-	0.64
SG32		AMPHIBOLE		J =	0.00094	+-	3.8E-06	(1 s.d.)		Exp. No.:	L5101.IHD	Total gas age =			56.63	+-	0.26
Marsco granite																	
dgs1	72.76	4.988	0.13136	0.57	1.09	1.85	7.07	1.20E-15	47.2	0	0.35	1.04	0.098	0.8	57.39	+-	4.76
fs2	36.13	4.052	0.010343	0.13	0.34	0.76	8.44	1.10E-14	92.4	0	0.28	10.7	0.121	8.1	55.81	+-	0.44
dgs2	42.63	4.256	0.03372	0.13	0.37	0.62	2.66	7.90E-15	77.4	0	0.3	3.45	0.115	5.8	55.17	+-	0.51
fs1	36.53	5.522	0.009619	0.13	0.3	1.37	10.08	8.40E-15	93.4	0	0.39	15.67	0.088	5.9	57.07	+-	0.45
fs3	39.01	3.458	0.019413	0.12	0.21	0.78	5.01	1.00E-14	86	0	0.24	4.86	0.141	7.3	56.03	+-	0.48
fs4	35.08	3.932	0.006828	0.12	0.31	1.21	9.6	9.50E-15	95.2	0	0.27	15.72	0.124	6.9	55.76	+-	0.33
dgs3	121.9	3.85	0.2793	0.15	0.56	1.38	2.29	3.20E-15	32.5	0	0.27	0.38	0.127	1.9	66.09	+-	3.39
fs5	38.86	4.14	0.016646	0.12	0.15	0.75	3.73	2.40E-14	88.2	0	0.29	6.79	0.118	16.5	57.25	+-	0.31
fs6	35.44	4.69	0.006821	0.18	0.28	0.78	20.81	9.40E-15	95.4	0	0.33	18.77	0.104	6.7	56.5	+-	0.59
fs7	35.27	3.885	0.006132	0.09	0.15	0.49	7.5	3.00E-14	95.8	0	0.27	17.3	0.126	21.6	56.42	+-	0.21
fs8	37.71	3.488	0.013915	0.15	0.3	0.9	11.55	8.50E-15	89.8	0	0.24	6.84	0.14	6	56.56	+-	0.76
fs9	35.54	3.948	0.006696	0.14	0.09	0.3	11.2	1.70E-14	95.3	0	0.28	16.1	0.124	12.4	56.59	+-	0.32
SG27		arfedsonite		J =	0.00093	+-	4.6E-06	(1 s.d.)		Exp. No.:	L5102.IHD	Total gas age =			69.29	+-	0.41
Glamaich granite																	
dgs1	52.85	3.421	0.03903	0.05	0.27	0.52	1.3	3.40E-14	78.7	0	0.24	2.39	0.143	35.2	68.47	+-	0.35
fs10	41.93	3.124	0.010308	0.18	0.4	1.29	10.03	9.00E-15	93.3	0	0.22	8.27	0.157	9.9	64.49	+-	0.55
fs12	43.4	3.45	0.014607	0.19	0.51	0.83	9.99	7.70E-15	90.7	0	0.24	6.45	0.142	8.4	64.88	+-	0.77
fs11	67.34	4.503	0.03552	0.26	0.49	1.02	11.53	4.70E-15	84.9	0	0.31	3.46	0.108	3.5	93.6	+-	1.98
fs13	52.36	4.068	0.03698	0.12	0.28	0.33	3.61	9.20E-15	79.8	0	0.28	3	0.12	9.4	68.78	+-	0.68
dgs2	55.9	2.938	0.05069	0.1	0.1	0.46	1.87	1.90E-14	73.6	0	0.21	1.58	0.166	19.6	67.75	+-	0.47
fs14	42.67	4.089	0.02348	0.41	0.6	1.46	17.79	3.10E-15	84.5	0	0.29	4.75	0.119	3.7	59.54	+-	2

fs15	81.12	4.419	0.04789	0.26	0.61	1.87	9.92	5.10E-15	83	0	0.31	2.52	0.111	3.2	109.65	+-	2.36
fs16	45.22	2.849	0.02159	0.22	0.29	1.08	9.33	6.30E-15	86.4	0	0.2	3.6	0.172	7	64.38	+-	0.98
SG27		arfedsonite		J =	0.00093	+-	2.8E-06	(1 s.d.)		Exp. No.: L5108.IHD		Total gas age =			68.73	+-	0.43
Glamaich granite																	
1.3	87.48	2.978	0.12987	0.14	0.57	0.81	1.48	7.80E-15	56.4	0	0.21	0.63	0.164	16.5	81.32	+-	1.29
1.5	68.24	2.409	0.113	2.36	3.14	13.13	22.77	2.50E-16	51.4	0	0.17	0.58	0.203	0.7	58.1	+-	13.24
1.8	54	3.208	0.04393	0.6	0.7	2.12	9.04	1.60E-15	76.4	0	0.22	1.99	0.152	4	68.28	+-	2.05
2.2	41.44	3.172	0.017177	0.26	0.45	0.61	6.01	8.30E-15	88.4	0	0.22	5.04	0.154	23.6	60.7	+-	0.59
2.4	46.44	3.315	0.03845	0.5	0.38	2.05	6.88	2.30E-15	76.1	0	0.23	2.35	0.147	6.6	58.63	+-	1.34
2.8	45.59	3.096	0.02939	0.25	0.56	0.93	3.3	7.40E-15	81.5	0	0.22	2.88	0.158	20.6	61.56	+-	0.65
3.4	43.74	3.593	0.02923	0.3	0.82	1.25	5.7	3.90E-15	80.9	0	0.25	3.36	0.136	11.5	58.73	+-	1.01
fuse	63.23	5.167	0.03442	0.18	0.79	0.58	3.07	8.50E-15	84.6	0	0.36	4.1	0.094	16.4	88.09	+-	0.97
U117		biotite		J =	0.00094	+-	2.8E-06	(1 s.d.)		Exp. No.: L5103.IHD		Total gas age =			55.17	+-	0.18
an dubhaich granite																	
1dgs	77.85	0.04613	0.17739	0.07	0.75	15.41	1.57	4.70E-15	32.7	0	0	0.01	10.62	1.9	42.39	+-	1.79
2dgs	60.12	0.3837	0.09741	0.09	0.31	2.71	1.43	1.10E-14	52.2	0	0.03	0.11	1.277	3.4	52.17	+-	0.77
19fs	34.35	0.018531	0.004062	0.2	0.26	27.14	10.78	2.70E-14	96.5	0	0	0.12	26.44	8.2	55.06	+-	0.28
21fs	40.69	2.21	0.019339	0.61	1.58	2.82	23.69	1.90E-15	86.4	0	0.15	3.12	0.221	0.5	58.43	+-	2.43
22fs	34.68	0.04407	0.003279	0.08	0.2	2.6	5.1	5.00E-14	97.2	0	0	0.37	11.12	15	55.99	+-	0.15
23fs	35.93	0.002426	0.007808	0.11	0.14	43.6	3.14	5.20E-14	93.6	0	0	0.01	202	15.5	55.84	+-	0.16
24fs	34.77	0.00527	0.003948	0.11	0.2	25.19	6.02	4.50E-14	96.6	0	0	0.04	92.99	13.6	55.81	+-	0.18
25fs	37.12	0.014849	0.013365	0.03	0.03	6.07	1.38	6.90E-14	89.4	0	0	0.03	33	20.9	55.09	+-	0.1
26fs	35.44	0.017706	0.007274	0.08	0.08	8.81	1.96	7.00E-14	93.9	0	0	0.07	27.67	21	55.3	+-	0.1
SG16		Biotite		J =	0.00093	+-	2.8E-06	(1 s.d.)		Exp. No.: L5091.IHD		Total gas age =			57.3	+-	2.01
Loch Ainort granite																	
1.4	1655.5	0.008736	5.498	0.05	0.47	100	0.23	1.10E-14	1.9	0	0	0	56.09	10.3	51.44	+-	19.47
1.6	49.43	0.02146	0.05226	0.33	0.62	61.49	2	3.10E-15	68.8	0	0	0.01	22.83	2.7	56.37	+-	0.78
1.4*	41.53	0.02289	0.02287	0.11	0.24	13.82	2.03	1.10E-14	83.7	0	0	0.03	21.4	9.5	57.66	+-	0.29
1.6*	44.07	0.010706	0.02852	0.13	0.3	29.06	2.67	1.20E-14	80.9	0	0	0.01	45.77	10.1	59.08	+-	0.44
2	38.89	0.016724	0.012783	0.08	0.3	9.26	2.28	1.70E-14	90.3	0	0	0.04	29.3	14.5	58.21	+-	0.25
2.2	38.22	0.009636	0.010054	0.05	0.15	10.28	2.5	3.10E-14	92.2	0	0	0.03	50.85	26.4	58.43	+-	0.16
2.6	37.76	0.009044	0.010527	0.06	0.32	20.41	2.24	2.00E-14	91.8	0	0	0.02	54.18	16.9	57.44	+-	0.23
3	63.68	0.2702	0.10336	0.74	1.42	18.79	4.75	7.40E-16	52.1	0	0.02	0.07	1.813	0.7	55.03	+-	3
tfi	38.44	0.018988	0.013744	0.13	0.29	21.18	2.92	1.00E-14	89.4	0	0	0.04	25.8	9	57.02	+-	0.28
SG16		biotite		J =	0.00093	+-	2.8E-06	(1 s.d.)		Exp. No.: L5106.IHD		Total gas age =			68.13	+-	0.38
Loch Ainort granite																	
1.6	118.37	0.04497	0.329	0.05	0.22	18.48	1.27	6.70E-15	17.9	0	0	0	10.89	12.2	35.25	+-	2.14
2.1	76.25	0.04073	0.1334	0.06	0.38	14.99	1.08	1.50E-14	48.3	0	0	0.01	12.03	16.2	60.99	+-	0.89
2.2	65.47	0.02921	0.06987	0.04	0.19	9.73	0.44	3.60E-14	68.5	0	0	0.01	16.77	31.5	73.96	+-	0.27
2.6	62.57	0.05717	0.0525	0.11	0.35	12.41	1.3	1.70E-14	75.2	0	0	0.03	8.57	14.2	77.57	+-	0.51
3	61.98	0.05663	0.052	0.11	0.34	12.41	1.3	1.70E-14	75.2	0	0	0.03	8.65	14.3	76.86	+-	0.5
10	50.56	0.02732	0.018787	0.21	0.23	32.43	3.81	1.30E-14	89	0	0	0.04	17.93	11.6	74.25	+-	0.43

SG16		Biotite		J =	0.00093	+-	2.8E-06	(1 s.d.)		Exp. No.:	L5107.IHD	Total gas age =			48.3	+-	3.47
Loch Ainort granite																	
1.5	2733	0.2865	9.488	0.06	1.21	21.22	0.41	-1.50E-14	-2.6	0	0.02	0	1.71	4.3	%-123.53	+-	89.1
2.1	272.7	0.03857	0.8594	0.04	0.32	12.98	0.21	7.30E-15	6.9	0	0	0	12.7	7.6	31.29	+-	2.29
2.2	44.6	0.00872	0.0364	0.17	0.33	35.29	1.36	2.50E-14	75.9	0	0	0.01	56.19	14.3	56.19	+-	0.37
2.4	40.03	0.018611	0.018857	0.16	0.37	50.4	3.75	9.30E-15	86.1	0	0	0.03	26.33	5.3	57.19	+-	0.44
2.8	38.3	0.006269	0.010306	0.07	0.18	21.54	1.28	5.70E-14	92.1	0	0	0.02	78.17	31.8	58.5	+-	0.14
3.4	36.91	0.0044	0.006168	0.13	0.19	59.66	3.84	3.70E-14	95.1	0	0	0.02	111.4	20.4	58.21	+-	0.18
4	39.72	0.06285	0.013673	0.4	0.7	49.59	26.91	2.30E-15	89.8	0	0	0.13	7.8	1.3	59.2	+-	1.85
fuse	37.52	0.017741	0.01136	0.18	0.28	17.95	3.13	2.60E-14	91.1	0	0	0.04	27.62	15	56.71	+-	0.27
SG16		biotite		J =	0.00094	+-	2.8E-06	(1 s.d.)		Exp. No.:	L5109.IHD	Total gas age =			47.62	+-	0.18
Loch Ainort granite																	
1.3	43.06	0.017143	0.07338	0.07	0.18	8.56	0.54	3.70E-14	49.6	0	0	0.01	28.58	31.4	35.72	+-	0.26
1.8	38.42	0.02317	0.02699	0.14	0.15	11.25	0.83	3.80E-14	79.2	0	0	0.02	21.14	22.9	50.66	+-	0.17
2.3	37.59	0.01408	0.017037	0.17	0.31	15.25	0.9	3.90E-14	86.6	0	0	0.02	34.8	21.8	54.12	+-	0.24
2.8	38.22	0.04249	0.02083	0.28	0.4	14.48	2.27	1.50E-14	83.9	0	0	0.06	11.53	8.5	53.32	+-	0.39
fuse	37.84	0.02245	0.01615	0.1	0.2	14.01	1.93	2.80E-14	87.4	0	0	0.04	21.82	15.4	54.96	+-	0.21
SG16		biotite		J =	0.00093	+-	2.8E-06	(1 s.d.)		Exp. No.:	L5110.IHD	Total gas age =			57.56	+-	0.3
Loch Ainort granite																	
1.8	56.62	-0.002596	0.07939	0.23	0.47	%-137.43	1.93	2.20E-14	58.6	0	0	0	%-188.7416	24	55.07	+-	0.91
2	38.7	0.005925	0.009921	0.11	0.33	40.91	1.63	3.70E-14	92.4	0	0	0.02	82.7	36.5	59.34	+-	0.24
2.2	38.53	0.012634	0.012021	0.07	0.28	24.84	2.43	2.50E-14	90.8	0	0	0.03	38.78	25.6	58.05	+-	0.23
2.4	43.97	0.011676	0.03698	0.28	0.44	181.41	4.75	3.00E-15	75.2	0	0	0.01	41.97	3.2	54.88	+-	0.93
2.8	53.34	0.08111	0.07468	0.41	0.61	64.24	4.46	1.60E-15	58.6	0	0.01	0.03	6.04	1.8	51.99	+-	1.75
fuse	43.16	0.03199	0.02845	0.11	0.31	25.37	2.94	8.60E-15	80.5	0	0	0.03	15.32	8.9	57.68	+-	0.47
SG16		biotite		J =	0.00093	+-	2.8E-06	(1 s.d.)		Exp. No.:	L5111.IHD	Total gas age =			60.07	+-	0.75
Loch Ainort granite																	
1.3	123.35	0.008277	0.3423	0.34	1.14	129.29	1.64	4.40E-15	18	0	0	0	59.2	15.8	37	+-	4.15
1.5	77.3	0.03887	0.13892	0.28	0.73	28.71	1.31	8.30E-15	46.9	0	0	0.01	12.61	18.1	60.05	+-	1.41
1.7	72.91	0.10792	0.11252	0.35	0.46	38.86	3.44	1.90E-15	54.4	0	0.01	0.03	4.54	3.8	65.61	+-	2
2	63.32	0.008913	0.07528	0.23	0.51	147.28	1.48	7.20E-15	64.9	0	0	0	54.97	13.9	67.89	+-	0.81
2.4	52.07	0.010012	0.04298	0.2	0.48	87	1.26	1.50E-14	75.6	0	0	0.01	48.94	30.8	65.11	+-	0.52
2.9	50.97	0.08267	0.04458	0.26	0.72	36.71	3.54	3.30E-15	74.2	0	0.01	0.05	5.93	6.9	62.58	+-	1.01
fuse	47.58	0.04276	0.02688	0.2	0.63	36.45	3.35	5.40E-15	83.3	0	0	0.04	11.46	10.8	65.57	+-	0.67
SG16		biotite		J =	0.00093	+-	2.8E-06	(1 s.d.)		Exp. No.:	L5113.IHD	Total gas age =			55.52	+-	0.32
Loch Ainort granite																	
0.9	157.6	-0.118443	0.4962	0.39	1.23	-98.03	2.81	2.40E-16	7	0	-0.01	-0.01	%-4.1374	1.1	18.404	+-	8.274
1.1	66.15	0.003439	0.16045	0.19	0.47	224.95	1.52	2.50E-15	28.3	0	0	0	142.5	6.9	31.32	+-	1.38
1.3	178.23	-0.177964	0.5159	0.7	2.47	%-135.85	6.87	2.20E-16	14.5	0	-0.01	-0.01	%-2.7537	0.4	42.93	+-	19.86
1.7	46.83	0.010694	0.05664	0.08	0.33	58.72	1.96	8.90E-15	64.3	0	0	0.01	45.82	15.2	50.05	+-	0.61
1.9	46.25	0.011597	0.03354	0.08	0.29	40.98	2.96	1.40E-14	78.6	0	0	0.01	42.25	19.6	60.28	+-	0.53
2.1	57.88	0.0554	0.08038	0.34	0.66	60.31	4.46	2.80E-15	59	0	0	0.02	8.84	4.2	56.66	+-	1.89
2.4	49.58	0.006717	0.04658	0.23	0.39	211.25	3.84	5.90E-15	72.2	0	0	0	72.95	8.5	59.41	+-	0.95

2.9	42.42	0.008866	0.02263	0.1	0.32	46.44	2.47	1.80E-14	84.2	0	0	0.01	55.27	26.5	59.29	+-	0.36
fuse	43.32	0.008116	0.02583	0.11	0.49	92.68	3.36	1.20E-14	82.4	0	0	0.01	60.38	17.6	59.21	+-	0.56
SG16		biotite		J =	0.00094	+-	2.8E-06	(1 s.d.)		Exp. No.: L5114.IHD		Total gas age =			60.91	+-	0.38
Loch Ainort granite																	
0.8	122.9	-0.085222	0.3141	0.16	0.7	-13.54	1.31	3.30E-15	24.5	0	-0.01	-0.01	%-5.7501	5.7	50.05	+-	2.71
1.3	86.84	-0.019537	0.2267	0.1	0.55	%-118.86	1.53	2.70E-15	22.8	0	0	0	%-25.0803	6.9	33.18	+-	1.98
1.7	91.47	-0.045835	0.2152	0.24	0.74	-87.66	3.04	1.30E-15	30.5	0	0	-0.01	%-10.6909	2.5	46.46	+-	3.48
1.8	64.51	0.004743	0.09131	0.1	0.43	164.26	1.74	1.20E-14	58.2	0	0	0	103.3	16.4	62.25	+-	0.92
2	60.07	-0.004858	0.07118	0.2	0.49	%-445.69	3.52	4.00E-15	65	0	0	0	%-100.8637	5.3	64.7	+-	1.32
2.4	59.22	0.001509	0.06593	0.08	0.33	526.96	1.86	1.40E-14	67.1	0	0	0	324.6	18.3	65.84	+-	0.69
2.9	50.84	-0.002679	0.0397	0.08	0.28	%-111.95	1.58	2.20E-14	76.9	0	0	0	%-182.9005	29	64.81	+-	0.39
fuse	43.11	-0.01162	0.016125	0.15	0.36	-54.37	5.78	1.20E-14	88.9	0	0	-0.02	%-42.1705	15.9	63.56	+-	0.53

(a) Steps labeled either as temperature (deg C), laser power (W),or individual total fusion analyses (TF#).
(b) Corrected for 37Ar and 39Ar decay, half-lives 35.1 days and 259 years, respectively.
(c) Radiogenic (R), calcium-derived (Ca), and potassium-derived (K) argon, respectively (percent).
(d) Ages calculated relative to 85G003 TCR Sanidine at 27.92 Ma with lambda e = 0.581E-10/yr and lambda b = 4.692E-10/yr.

Results table for Mull

Step (a)	40Ar/39Ar (b)	37Ar/39Ar (b)	36Ar/39Ar (b)	40Ar s.d. (%)	39Ar s.d. (%)	37Ar s.d. (%)	36Ar s.d. (%)	40ArR (mol)	40ArR (c)	40ArK (c)	39ArCa (c)	36ArCa (c)	K/Ca (%)	39Ar (%)	Apparent Age (Ma)	+-	1 s.d. (Ma)
B1	wr lch 250-500			J =	0.00182	+-	5.5E-06	(1 s.d.)		Exp. No.:	LC8F0044.IHD	Total gas age =			61.54	+-	0.19
15	39.1	3.824	0.04926	0.06	0.07	0.56	0.47	2.00E-13	63.5	0	0.26	2.05	0.128	1.1	79.83	+-	0.25
16.5	29.56	2.825	0.02422	0.07	0.09	2.05	2.34	6.60E-14	76.5	0	0.19	3.08	0.173	0.4	72.81	+-	0.51
18	25.15	2.345	0.011395	0.09	0.14	0.5	0.82	3.70E-13	87.3	0	0.16	5.43	0.209	2.4	70.7	+-	0.16
19.5	22.57	2.298	0.006211	0.04	0.05	0.36	1.25	5.00E-13	92.7	0	0.15	9.77	0.213	3.4	67.37	+-	0.09
21	20.89	2.692	0.004016	0.08	0.05	0.74	5.35	1.30E-12	95.3	0	0.18	17.7	0.182	8.9	64.23	+-	0.18
22.5	19.721	2.846	0.002465	0.06	0.09	0.5	6.05	1.80E-12	97.4	0	0.19	30.47	0.172	13.1	62.02	+-	0.12
24	19.376	2.329	0.001878	0.03	0.09	0.52	8.19	2.00E-12	98.1	0	0.16	32.75	0.21	14.7	61.33	+-	0.12
25.5	19.041	1.4965	0.001348	0.04	0.11	0.71	8.1	2.30E-12	98.5	0	0.1	29.31	0.327	17.5	60.52	+-	0.1
26.5	19.011	1.1826	0.001479	0.04	0.07	1.79	13.27	1.20E-12	98.2	0	0.08	21.11	0.414	9	60.21	+-	0.15
27.5	19.183	1.3116	0.00228	0.07	0.04	2.17	10.44	9.40E-13	97	0	0.09	15.19	0.373	7.1	60.05	+-	0.19
29	19.099	1.5497	0.002098	0.06	0.06	1.31	10.94	9.80E-13	97.4	0	0.1	19.5	0.316	7.4	60.02	+-	0.18
31	19.304	1.9738	0.003323	0.07	0.12	1.76	11.94	5.80E-13	95.7	0	0.13	15.68	0.248	4.4	59.64	+-	0.32
33.5	19.148	2.516	0.004344	0.05	0.09	0.42	1.35	5.60E-13	94.3	0	0.17	15.29	0.194	4.4	58.34	+-	0.09
37	19.497	21.34	0.012763	0.07	0.1	0.46	5.3	4.90E-13	89.2	0	1.44	44.13	0.023	3.9	56.92	+-	0.36
43	19.834	89.24	0.03096	0.03	0.09	0.21	2.08	2.30E-13	89	0	6.01	76.1	0.0052	1.7	60.51	+-	0.18
50	22.52	66.14	0.03205	0.07	0.17	0.26	2.47	8.10E-14	80.9	0	4.45	54.48	0.0071	0.6	61.42	+-	0.38
BB6	wr lch 250-500			J =	0.00186	+-	5.6E-06	(1 s.d.)		Exp. No.:	LC8F0047.IHD	Total gas age =			68.13	+-	0.24
15	33.05	10	0.04718	0.18	0.13	0.42	1.18	5.10E-13	60.2	0	0.67	5.6	0.049	20	65.81	+-	0.56
16	28.21	8.372	0.04138	0.45	0.83	3.84	10.04	7.50E-15	59	0	0.56	5.34	0.058	0.4	55.16	+-	3.8
17.*	20.11	9.858	0.006939	0.03	0.09	0.15	2.35	3.40E-13	93.6	0	0.66	37.5	0.049	14.1	62.37	+-	0.12
19.*	19.634	10.374	0.006135	0.02	0.08	0.27	2.41	4.10E-13	94.9	0	0.7	44.64	0.047	17.1	61.74	+-	0.1
20.5	20.54	10.471	0.00778	0.05	0.09	0.28	2.53	2.80E-13	92.8	0	0.7	35.53	0.046	11.7	63.15	+-	0.14
22	22.56	12.257	0.010218	0.06	0.07	0.27	3.23	1.70E-13	90.9	0	0.82	31.67	0.04	6.5	67.91	+-	0.23
23.5	25.48	15.021	0.012768	0.04	0.1	0.17	3.27	1.40E-13	89.8	0	1.01	31.06	0.032	4.8	75.77	+-	0.29
25	25.98	16.245	0.013946	0.06	0.12	0.35	4.09	1.00E-13	89	0	1.09	30.75	0.03	3.5	76.64	+-	0.39
26.5	27.47	16.74	0.017834	0.05	0.15	0.43	3.67	8.30E-14	85.6	0	1.13	24.78	0.029	2.8	77.9	+-	0.48
28	29.43	15.306	0.02181	0.06	0.14	0.43	3.01	8.00E-14	82.2	0	1.03	18.53	0.032	2.6	79.99	+-	0.52
30	30.56	12.78	0.02244	0.08	0.16	0.52	3.77	6.10E-14	81.6	0	0.86	15.04	0.038	1.9	82.28	+-	0.69
33.?	34.85	10.071	0.02618	0.05	0.18	0.55	2.41	9.40E-14	80.1	0	0.68	10.16	0.048	2.7	91.69	+-	0.57
30.*	57.41	9.785	0.09384	0.27	0.84	5.72	4.89	9.60E-15	53	0	0.66	2.75	0.05	0.2	99.79	+-	4.45
34	37.71	11.757	0.03839	0.06	0.15	0.52	1.7	7.00E-14	72.3	0	0.79	8.08	0.041	2	89.81	+-	0.6
43	47.5	114.57	0.12292	0.07	0.11	0.04	0.25	2.70E-13	42.3	0	7.71	24.61	0.0039	9.8	71.54	+-	0.39
T1	WR LCH 250-500			J =	0.00176	+-	5.3E-06	(1 s.d.)		Exp. No.:	LC8F0046.IHD	Total gas age =			61.36	+-	0.2

15	256.1 ;-7.426350		0.8924	2.06	32.62 %-223.70		17.78	-6.80E-17	-3.2	0	-0.5	-0.22	-0.0663	0	-25.92	+-	409.72
28	20.43	2.639	0.002561	0.1	0.1	0.26	1.52	8.60E-12	97.3	0	0.18	27.21	0.185	77.7	62	+-	0.1
29.5	19.795	2.213	0.002386	0.07	0.08	0.83	10.13	1.40E-12	97.3	0	0.15	24.49	0.221	13.1	60.1	+-	0.18
31	19.997	2.585	0.003659	0.05	0.08	0.34	2.9	3.20E-13	95.6	0	0.17	18.65	0.189	3	59.67	+-	0.1
32.5	19.389	3.648	0.004925	0.03	0.09	0.29	2.09	3.00E-13	94	0	0.25	19.56	0.134	3	56.94	+-	0.1
34	20.33	12.067	0.012829	0.06	0.08	0.37	1.71	1.40E-13	86	0	0.81	24.83	0.04	1.4	54.99	+-	0.16
37	20.59	131.66	0.04979	0.07	0.11	0.28	2.6	9.00E-14	78.4	0	8.86	69.81	0.0034	0.9	55.28	+-	0.41
43	21	213.2	0.07069	0.08	0.08	0.25	2.66	8.50E-14	79.7	0	14.35	79.64	0.002	0.8	60.88	+-	0.44
50	38.9	146.27	0.1106	0.27	0.77	0.32	3.31	1.10E-14	45.3	0	9.84	34.92	0.003	0.1	60.92	+-	2.66
T3	PLAG CONC			J =	0.00179	+-	5.4E-06	(1 s.d.)	Exp. No.:		LC8F0045.IHD	Total gas age =			63.82	+-	0.21
15	291.4	14.802	0.8823	0.11	0.69	3.09	0.33	2.00E-14	10.9	0	1	0.44	0.033	0.6	100.9	+-	8.78
18	32.73	7.957	0.04081	0.05	0.27	1.79	1.53	4.40E-14	65.1	0	0.54	5.15	0.061	2.1	67.84	+-	0.61
16.5	59.84	12.864	0.11188	0.12	0.18	1.03	0.58	6.30E-14	46.4	0	0.87	3.04	0.038	2.3	88.29	+-	0.73
20	24.29	6.109	0.017441	0.09	0.11	0.85	0.97	1.80E-13	80.7	0	0.41	9.25	0.08	9.4	62.48	+-	0.18
22	22.78	4.763	0.013374	0.07	0.08	0.83	1.03	2.30E-13	84.3	0	0.32	9.4	0.103	12.5	61.13	+-	0.14
24	22.11	6.275	0.012032	0.07	0.13	0.84	1.53	1.70E-13	86.1	0	0.42	13.77	0.078	9.3	60.72	+-	0.18
26	22.06	9.994	0.013171	0.04	0.07	0.51	1.18	2.00E-13	85.9	0	0.67	20.03	0.049	10.8	60.56	+-	0.13
28	22.23	14.129	0.014889	0.05	0.07	0.46	1.68	1.50E-13	85.2	0	0.95	25.05	0.034	8.3	60.68	+-	0.18
30	22.01	15.193	0.014385	0.05	0.11	0.5	2.44	1.20E-13	86.1	0	1.02	27.88	0.032	6.7	60.75	+-	0.25
32	21.83	13.353	0.013708	0.06	0.07	0.51	1.86	1.40E-13	86.2	0	0.9	25.72	0.036	7.8	60.3	+-	0.19
34	21.41	12.824	0.01332	0.06	0.11	0.66	2.31	1.10E-13	86.3	0	0.86	25.42	0.038	5.9	59.19	+-	0.23
37	23.05	15.935	0.016602	0.04	0.14	0.42	1.47	1.40E-13	84.1	0	1.07	25.34	0.03	7.4	62.19	+-	0.2
43	25.1	118.06	0.0497	0.06	0.09	0.05	0.59	2.80E-13	78.2	0	7.95	62.72	0.0038	13.4	67.56	+-	0.17
50	36.61	140.07	0.07485	0.06	0.13	0.14	1.61	9.10E-14	69.4	0	9.43	49.41	0.0032	3.4	88.41	+-	0.64
BM64	WR LCH 250-500			J =	0.00199	+-	0.000006	(1 s.d.)	Exp. No.:		LC8F0066.IHD	Total gas age =			59.58	+-	0.18
13	48.92	0.9783	0.11999	0.14	0.68	14.2	1.59	1.70E-14	27.7	0	0.07	0.22	0.501	0.1	48.05	+-	2.41
14	23	1.1206	0.02663	0.05	0.1	4.85	1.06	1.00E-12	66.2	0	0.08	1.11	0.437	3.8	53.93	+-	0.3
15	22.01	0.5836	0.008252	0.1	0.16	9.56	4.31	1.20E-12	89.1	0	0.04	1.87	0.839	3.5	69.2	+-	0.38
16	20.04	0.4859	0.004752	0.07	0.04	0.97	1.28	1.10E-12	93.2	0	0.03	2.7	1.008	3.6	65.93	+-	0.09
17	19.446	0.6618	0.006076	0.07	0.12	3.25	3.92	1.10E-12	91	0	0.04	2.88	0.74	3.5	62.57	+-	0.25
18	18.717	0.5939	0.004247	0.06	0.1	2.4	4.02	1.50E-12	93.5	0	0.04	3.69	0.825	5	61.9	+-	0.18
19	18.191	0.6543	0.003832	0.06	0.07	3.85	5.02	1.40E-12	94.1	0	0.04	4.51	0.749	4.7	60.51	+-	0.2
20	18.403	0.6393	0.003846	0.1	0.05	2.42	3.27	2.20E-12	94.1	0	0.04	4.39	0.766	7.5	61.23	+-	0.14
21	18.476	0.4865	0.004886	0.16	0.21	5.08	6.07	8.70E-13	92.4	0	0.03	2.63	1.007	3	60.37	+-	0.34
22.2	18.3	0.4819	0.003962	0.07	0.06	2.51	4.29	1.40E-12	93.8	0	0.03	3.21	1.017	4.8	60.71	+-	0.18
23.5	17.9	0.5092	0.003909	0.05	0.06	3.1	5.42	1.10E-12	93.8	0	0.03	3.44	0.962	3.9	59.38	+-	0.21
25	17.685	0.5341	0.004054	0.11	0.07	3.17	6.41	1.10E-12	93.5	0	0.04	3.48	0.917	3.9	58.49	+-	0.27
27	17.298	0.6822	0.003216	0.03	0.07	1.86	3.56	2.10E-12	94.8	0	0.05	5.6	0.718	7.6	58.05	+-	0.12
30	17.148	0.8272	0.003015	0.04	0.05	0.69	3.44	3.30E-12	95.2	0.01	0.06	7.24	0.592	12	57.78	+-	0.11
33	17.194	0.9645	0.003206	0.02	0.04	0.65	2.96	3.60E-12	94.9	0.01	0.06	7.94	0.508	12.8	57.78	+-	0.1

37	17.854	3.307	0.005654	0.03	0.06	0.24	2.03	3.00E-12	92.1	0	0.22	15.44	0.148	10.8	58.29	+-	0.11
43	20.01	3.161	0.012259	0.01	0.04	0.21	1.01	2.70E-12	83.1	0	0.21	6.81	0.155	9.4	58.97	+-	0.13
BM67	wr lch 250-500			J =	0.00201	+-	0.000005	(1 s.d.)		Exp. No.:	LC8F0042.IHD	Total gas age =			59.46	+-	0.16
14	78.09	6.824	0.2319	0.19	1.38	2.41	1.81	4.10E-15	12.9	0	0.46	0.78	0.071	0.2	36.42	+-	6.3
15.5	71.06	6.551	0.1922	0.14	0.19	0.23	0.35	1.20E-13	20.8	0	0.44	0.9	0.074	3.1	53.01	+-	0.97
17	29.5	5.836	0.04516	0.14	0.22	0.36	0.66	7.80E-14	56.3	0	0.39	3.41	0.084	1.8	59.43	+-	0.4
18.5	24.73	5.396	0.02843	0.07	0.1	0.3	0.79	1.70E-13	67.7	0	0.36	5.01	0.09	3.8	59.92	+-	0.24
20	21.77	5.109	0.019476	0.13	0.14	0.4	1.48	9.40E-14	75.4	0	0.34	6.93	0.096	2.2	58.73	+-	0.3
21.5	19.669	6.08	0.012247	0.08	0.09	0.31	0.98	2.60E-13	84	0	0.41	13.11	0.08	5.9	59.15	+-	0.13
23	18.496	7.158	0.008803	0.08	0.07	0.27	1.25	2.60E-13	89	0	0.48	21.47	0.068	6	58.94	+-	0.11
24.5	18.639	6.474	0.008562	0.05	0.06	0.26	2.09	1.80E-13	89.1	0	0.44	19.96	0.075	4	59.48	+-	0.15
26	18.044	4.67	0.006031	0.08	0.11	0.26	1.77	3.10E-13	92.1	0	0.31	20.44	0.105	7.1	59.45	+-	0.12
27.5	17.498	3.364	0.005005	0.06	0.14	0.41	2.97	1.80E-13	93	0	0.23	17.75	0.145	4.2	58.19	+-	0.15
29	17.713	3.407	0.005341	0.09	0.17	0.47	1.87	2.70E-13	92.6	0	0.23	16.84	0.143	6.2	58.61	+-	0.14
30.5	17.814	3.702	0.006328	0.1	0.06	0.37	1.62	2.90E-13	91.1	0	0.25	15.44	0.132	6.7	58.03	+-	0.11
32	17.91	4.265	0.007254	0.09	0.1	0.32	1.99	1.90E-13	89.9	0	0.29	15.52	0.115	4.5	57.58	+-	0.14
34	18.233	5.483	0.008316	0.03	0.06	0.27	1.17	3.20E-13	88.9	0	0.37	17.41	0.089	7.4	58	+-	0.09
37	20.61	13.393	0.016952	0.05	0.07	0.15	1.46	9.40E-13	80.8	0	0.9	20.86	0.036	21.2	59.88	+-	0.2
42	28.24	11.983	0.03901	0.09	0.06	0.3	0.79	7.10E-13	62.5	0	0.81	8.11	0.041	15.2	63.36	+-	0.3
50	43.02	12.557	0.09316	0.11	0.36	0.62	1.05	2.60E-14	38.3	0	0.85	3.56	0.039	0.6	59.21	+-	1.18
SO33	wr lch 250-500			J =	0.0019	+-	5.7E-06	(1 s.d.)		Exp. No.:	LC8F0043.IHD	Total gas age =			59.6	+-	0.24
15	59.41	6.735	0.10852	0.09	0.12	0.32	0.3	1.80E-13	46.9	0	0.45	1.64	0.072	2.1	93.63	+-	0.47
16.5	31.37	6.495	0.05263	0.07	0.16	0.63	0.96	5.80E-14	52	0	0.44	3.26	0.075	1.1	55.42	+-	0.52
18	26.99	5.532	0.04074	0.88	0.34	0.94	1.81	6.20E-13	57	0	0.37	3.59	0.088	12.8	52.23	+-	1.1
19.5	25.72	4.152	0.02964	0.25	0.27	0.74	1.88	4.40E-13	67.2	0	0.28	3.7	0.118	8.1	58.55	+-	0.61
21	26.72	3.671	0.03328	0.31	0.22	3.06	5.98	1.50E-14	64.3	0	0.25	2.91	0.133	0.3	58.14	+-	1.88
22.5	24.08	3.741	0.02383	0.07	0.09	0.82	2.08	4.60E-13	72	0	0.25	4.14	0.131	8.6	58.67	+-	0.47
24	21.28	4.314	0.01391	0.05	0.07	0.48	1.8	1.30E-13	82.3	0	0.29	8.19	0.113	2.4	59.27	+-	0.23
26	20.43	4.948	0.01093	0.04	0.05	0.21	0.79	4.30E-13	86.1	0	0.33	11.95	0.099	7.8	59.57	+-	0.09
29	20.17	6.098	0.011357	0.05	0.03	0.15	0.57	5.80E-13	85.7	0	0.41	14.18	0.08	10.7	58.63	+-	0.08
32	18.879	3.831	0.008006	0.07	0.08	0.5	4.13	7.30E-13	89	0	0.26	12.63	0.128	13.9	56.95	+-	0.29
36	19.213	4.304	0.010043	0.03	0.06	0.15	0.72	4.80E-13	86.3	0	0.29	11.31	0.114	9.2	56.2	+-	0.08
50	25.78	22.75	0.02912	0.05	0.07	0.07	0.29	1.40E-12	73.5	0	1.53	20.62	0.021	23.1	64.89	+-	0.11
SO17	wr lch 250-500			J =	0.00188	+-	5.6E-06	(1 s.d.)		Exp. No.:	LC8F0120.IHD	Total gas age =			78.06	+-	0.3
13	132.21	41.28	0.2749	0.1	0.56	1.77	0.26	1.30E-13	41	0	2.78	3.96	0.0115	3.9	179.78	+-	2.8
14	42.47	47.44	0.08967	0.06	0.66	1.89	0.89	4.00E-14	46.3	0	3.19	13.97	0.01	3.1	67.64	+-	1.29
15	34.59	47.72	0.06614	0.05	0.58	1.65	0.99	4.30E-14	54.3	0	3.21	19.05	0.0099	3.6	64.59	+-	0.93
16	32.04	44.96	0.05789	0.06	0.57	1.69	1.3	4.30E-14	57.5	0	3.03	20.51	0.0106	3.7	63.35	+-	0.91
17	31.55	43.03	0.05686	0.04	0.46	1.46	0.91	5.20E-14	57.4	0	2.9	19.98	0.0111	4.5	62.14	+-	0.69

18	28.19	40.71	0.04506	0.04	0.44	1.52	1.2	5.40E-14	64	0	2.74	23.85	0.0117	4.8	61.86	+-	0.62
19	27.74	41.82	0.0435	0.04	0.44	1.42	1.41	5.50E-14	65.4	0	2.81	25.38	0.0114	4.7	62.25	+-	0.64
20.2	25.6	43.05	0.03719	0.04	0.39	1.21	1.62	6.10E-14	70.2	0	2.9	30.56	0.0111	5.4	61.67	+-	0.55
21.5	23.88	44.17	0.03194	0.05	0.36	1.08	1.59	6.80E-14	74.9	0	2.97	36.51	0.0108	6	61.45	+-	0.45
23	23.1	42.46	0.03024	0.09	0.38	1.1	1.76	6.70E-14	75.6	0	2.86	37.06	0.0112	6.1	60	+-	0.47
25	24.33	41.31	0.03273	0.03	0.29	0.95	1.43	8.50E-14	73.5	0	2.78	33.32	0.0115	7.5	61.3	+-	0.4
28	25.67	34.86	0.03513	0.05	0.3	1.16	1.17	8.20E-14	70.2	0	2.35	26.2	0.0137	7.2	61.48	+-	0.41
32	28.18	27.27	0.04072	0.04	0.22	1.08	0.65	1.10E-13	64.8	0	1.84	17.68	0.0176	9.8	62.04	+-	0.32
37	64.2	103.99	0.17345	0.02	0.29	0.35	0.24	1.00E-13	32.8	0	7	15.83	0.0044	7.5	75.19	+-	0.9
43	59.53	72.56	0.13184	0.02	0.18	0.33	0.21	2.00E-13	44.1	0	4.88	14.53	0.0064	11.9	91.2	+-	0.52
50	70.88	61.29	0.13035	0.04	0.21	0.46	0.26	2.50E-13	52.4	0	4.12	12.41	0.0077	10.4	126.81	+-	0.66
LB1	sanidine 106-250			J =	0.00203	+-	6.1E-06	(1 s.d.)		Exp. No.:	LC8F0065.IHD	Total gas age =			58.98	+-	0.19
14	31.51	0.4469	0.04111	0.07	0.25	48.52	2.75	4.70E-14	61.6	0	0.03	0.29	1.096	0.4	69.83	+-	1.19
15	18.872	0.1593	0.005298	0.04	0.05	30.45	4.31	1.90E-13	91.8	0	0.01	0.79	3.08	1.8	62.46	+-	0.24
16	18.149	0.2366	0.005905	0.68	0.33	33.11	6.73	8.50E-13	90.5	0	0.02	1.06	2.07	8.6	59.28	+-	0.63
17	16.903	0.0745	0.001816	0.05	0.08	40.56	7.58	2.90E-13	96.9	0.01	0.01	1.08	6.58	2.9	59.1	+-	0.15
18	16.705	0.06047	0.001732	0.05	0.05	33.21	5.35	4.50E-13	97	0.01	0	0.92	8.1	4.6	58.48	+-	0.11
19	16.671	0.05892	0.001636	0.02	0.04	33.19	5.1	4.40E-13	97.1	0.01	0	0.95	8.32	4.5	58.46	+-	0.09
20	16.566	0.03995	0.001549	0.03	0.03	43.45	4.84	5.00E-13	97.3	0.01	0	0.68	12.27	5.1	58.17	+-	0.09
20.8	16.706	0.05162	0.0017	0.03	0.04	40	5.57	4.30E-13	97	0.01	0	0.8	9.49	4.4	58.51	+-	0.1
21.7	16.756	0.0455	0.001769	0.03	0.04	47.46	5.91	4.00E-13	96.9	0.01	0	0.68	10.77	4.1	58.61	+-	0.11
22.7	16.94	0.04791	0.002445	0.02	0.04	48.41	4.36	3.80E-13	95.8	0.01	0	0.52	10.23	3.9	58.56	+-	0.12
23.8	17.182	0.06098	0.003071	0.04	0.06	52.26	4.28	2.70E-13	94.7	0.01	0	0.52	8.03	2.8	58.77	+-	0.14
25.2	17.971	0.15806	0.005584	0.05	0.09	40.91	4.74	1.30E-13	90.9	0	0.01	0.75	3.1	1.4	58.96	+-	0.28
27	16.906	0.2793	0.00233	0.05	0.02	5.2	3.76	6.70E-13	96.1	0.01	0.02	3.16	1.754	6.9	58.63	+-	0.1
29	16.97	0.4616	0.002629	0.05	0.04	3.59	2.78	5.20E-13	95.6	0.01	0.03	4.63	1.061	5.4	58.6	+-	0.09
31	16.873	0.3134	0.002372	0.05	0.03	5.11	2.97	5.60E-13	96	0.01	0.02	3.49	1.563	5.7	58.48	+-	0.08
33	16.813	1.0504	0.002631	0.02	0.04	1.35	3.55	6.70E-13	95.9	0.01	0.07	10.54	0.466	6.9	58.23	+-	0.09
35	18.428	6.44	0.008959	0.08	0.05	0.67	2.71	1.20E-12	88.4	0	0.43	18.98	0.076	12.4	59.03	+-	0.21
37	19.652	3.999	0.012197	0.05	0.07	1.37	1.8	1.10E-12	83.2	0	0.27	8.66	0.122	11.2	59.21	+-	0.22
40	19.256	0.9074	0.009178	0.1	0.05	2.06	0.85	5.10E-13	86.3	0	0.06	2.61	0.54	5.1	59.99	+-	0.12
43	22.22	0.6035	0.017968	0.03	0.1	7.04	0.98	2.10E-13	76.3	0	0.04	0.89	0.812	2.1	61.2	+-	0.2
LB2	wr lch 250-500			J =	0.00203	+-	6.1E-06	(1 s.d.)		Exp. No.:	LC8F0064.IHD	Total gas age =			57.53	+-	0.18
12	31.76	1.3346	0.05367	0.1	0.58	19.23	4.18	1.60E-13	50.4	0	0.09	0.66	0.367	0.3	57.6	+-	2.47
13	21.27	0.19487	0.017323	0.03	0.07	19.22	2.57	1.20E-12	76	0	0.01	0.3	2.51	2.2	58.12	+-	0.48
14	19.385	0.0582	0.008025	0.03	0.06	38.78	2.96	2.20E-12	87.8	0	0	0.19	8.42	3.9	61.12	+-	0.26
15	18.492	0.17766	0.005916	0.04	0.09	9.14	2.98	2.30E-12	90.6	0	0.01	0.79	2.76	4.1	60.21	+-	0.2
16	18.249	0.15039	0.005007	0.02	0.04	12.5	4.37	2.40E-12	92	0	0.01	0.79	3.26	4.2	60.29	+-	0.23
17	18.961	0.10085	0.008062	0.02	0.02	9.62	1.28	5.20E-12	87.5	0	0.01	0.33	4.86	9.5	59.6	+-	0.12
18	17.469	0.05345	0.004543	0.03	0.03	17.3	2.47	4.70E-12	92.3	0	0	0.31	9.17	8.8	57.99	+-	0.13
19	16.672	0.08004	0.002741	0.03	0.03	12.81	5.38	3.30E-12	95.2	0.01	0.01	0.77	6.12	6.2	57.06	+-	0.16

20	16.475	0.07914	0.002774	0.02	0.03	10.22	4.48	4.30E-12	95.1	0.01	0.01	0.75	6.19	8.3	56.32	+-	0.14
21	16.156	0.0569	0.001682	0.02	0.03	24.73	11.04	3.00E-12	96.9	0.01	0	0.89	8.61	5.9	56.33	+-	0.2
23	16.351	0.05414	0.002596	0.03	0.03	27.6	6.79	3.20E-12	95.3	0.01	0	0.55	9.05	6.2	56.06	+-	0.19
25	16.826	0.11714	0.004636	0.03	0.04	11.28	5.23	2.50E-12	91.9	0.01	0.01	0.67	4.18	4.9	55.63	+-	0.26
27	17.456	0.10065	0.005843	0.02	0.04	20.1	3.77	2.20E-12	90.1	0	0.01	0.45	4.87	4.3	56.59	+-	0.24
30	18.309	0.08893	0.00853	0.06	0.05	33.4	1.9	4.30E-12	86.3	0	0.01	0.28	5.51	8.2	56.8	+-	0.18
33	18.897	0.2353	0.010696	0.03	0.02	5.21	0.7	5.80E-12	83.4	0	0.02	0.58	2.08	11.2	56.66	+-	0.09
37	21.36	0.2764	0.01859	0.04	0.04	3.29	0.8	5.20E-12	74.4	0	0.02	0.39	1.773	10	57.14	+-	0.17
43	50.9	0.3509	0.11789	0.01	0.09	11.98	0.5	9.10E-13	31.6	0	0.02	0.08	1.396	1.7	57.84	+-	0.69
MD1	felsic gmass 106-250			J =	0.00197	+-	5.9E-06	(1 s.d.)		Exp. No.:	LC8F0118.IHD	Total gas age =			60.28	+-	0.2
13	102.42	5.028	0.2571	0.1	2.39	147.87	1.64	7.10E-15	26.2	0	0.34	0.52	0.097	0.2	93.25	+-	10.89
14	75.25	5.24	0.16851	0.08	1.24	75.81	1.38	1.30E-14	34.4	0	0.35	0.82	0.093	0.4	89.92	+-	4.39
15	59.95	6.204	0.12051	0.07	0.72	36.76	1.13	2.10E-14	41.4	0	0.42	1.36	0.079	0.7	86.44	+-	2.17
16	43.6	6.578	0.07142	0.03	0.23	10.39	0.62	6.60E-14	52.8	0	0.44	2.43	0.074	2.3	80.27	+-	0.6
17	32.92	7.646	0.04839	0.19	0.74	28.8	2.73	1.20E-13	58.4	0	0.51	4.17	0.064	4.9	67.34	+-	1.6
18	26.52	6.991	0.0287	0.02	0.14	4.46	1.24	1.20E-13	70.1	0	0.47	6.43	0.07	5	65.13	+-	0.36
19	22.25	9.592	0.018751	0.02	0.07	1.69	0.6	2.10E-13	78.5	0	0.65	13.5	0.051	9.5	61.37	+-	0.13
20	20.25	13.485	0.015081	0.04	0.1	1.99	1.37	1.20E-13	83.2	0	0.91	23.61	0.036	5.7	59.39	+-	0.18
21	20.15	17.943	0.01693	0.03	0.06	0.71	0.6	2.60E-13	82.1	0	1.21	27.98	0.027	12.4	58.52	+-	0.1
22.2	19.717	18.935	0.016178	0.01	0.05	0.5	0.56	3.60E-13	83.2	0	1.27	30.9	0.026	16.9	58.11	+-	0.08
23.5	19.559	16.413	0.015211	0.03	0.08	1.04	1.28	1.90E-13	83.6	0	1.1	28.49	0.03	9.1	57.77	+-	0.16
25	20.84	14.774	0.018794	0.02	0.1	1.37	0.98	1.60E-13	78.9	0	0.99	20.75	0.033	7.6	58.02	+-	0.17
27	20.92	14.028	0.01872	0.04	0.08	1.6	0.86	1.50E-13	78.8	0	0.94	19.78	0.035	6.9	58.17	+-	0.16
30	20.88	10.467	0.018273	0.02	0.08	1.61	0.88	1.90E-13	78	0	0.7	15.12	0.046	9.1	57.37	+-	0.16
33	28.5	14.912	0.04566	0.03	0.12	2.19	0.54	9.90E-14	56.7	0	1	8.62	0.033	4.8	57.11	+-	0.28
37	31	93.18	0.07577	0.03	0.23	0.66	0.84	5.20E-14	51.2	0	6.27	32.47	0.0049	2.4	59.19	+-	0.57
43	33.29	426.7	0.1774	0.03	0.36	0.19	0.99	3.70E-14	42.5	0	28.72	63.51	0.0008	1.5	69.19	+-	1.33
50	35.66	294.8	0.15335	0.16	0.42	0.7	1.74	1.30E-14	37.4	0	19.84	50.74	0.0013	0.6	58.14	+-	1.91
MD2	felsic gmass 106-250			J =	0.00195	+-	5.9E-06	(1 s.d.)		Exp. No.:	LC8F0119.IHD	Total gas age =			61.38	+-	0.19
13	38.51	6.312	0.05516	0.03	0.07	0.94	0.22	2.90E-13	59	0	0.42	3.02	0.077	9.5	78.56	+-	0.19
14	27.55	6.395	0.02841	0.06	0.19	4.34	1.37	4.90E-14	71.3	0	0.43	5.94	0.076	1.9	68.22	+-	0.41
15	24.14	7.265	0.02	0.07	0.17	1.81	1.2	1.00E-13	77.9	0	0.49	9.59	0.067	4	65.32	+-	0.27
16	21.53	10.059	0.014836	0.03	0.07	0.67	1.01	1.90E-13	83.3	0	0.68	17.9	0.048	8	62.48	+-	0.14
17	20.03	13.879	0.013072	0.09	0.11	0.53	1.06	1.80E-13	86.1	0	0.93	28.03	0.035	7.9	60.29	+-	0.14
18	19.547	16.022	0.013136	0.06	0.06	0.38	0.98	2.00E-13	86.5	0	1.08	32.2	0.03	8.7	59.23	+-	0.11
19	19.689	16.055	0.014562	0.03	0.04	0.42	0.76	2.30E-13	84.5	0	1.08	29.11	0.03	10.1	58.28	+-	0.09
20	20.13	14.788	0.01518	0.03	0.06	0.46	0.82	1.90E-13	83.4	0	1	25.72	0.033	8.6	58.77	+-	0.11
21	20.55	12.464	0.016234	0.1	0.09	0.74	1.22	1.60E-13	81.4	0	0.84	20.27	0.039	7.1	58.43	+-	0.19
22.2	21.47	10.829	0.018362	0.03	0.1	0.85	1.01	1.30E-13	78.7	0	0.73	15.57	0.045	5.8	58.93	+-	0.18
23.5	22.36	9.699	0.02135	0.04	0.11	1.34	1.2	9.50E-14	75.2	0	0.65	11.99	0.05	4.2	58.61	+-	0.25
25	23.03	9.415	0.02312	0.04	0.11	1.23	0.86	1.00E-13	73.5	0	0.63	10.75	0.052	4.6	59.02	+-	0.21

27	22.9	9.239	0.02306	0.06	0.13	2.13	1.67	6.00E-14	73.4	0	0.62	10.58	0.053	2.7	58.59	+-	0.36
30	23.02	8.282	0.02426	0.03	0.09	1.05	0.56	1.40E-13	71.7	0	0.56	9.01	0.059	6.3	57.5	+-	0.15
33	26.03	10.314	0.03598	0.02	0.07	0.89	0.6	1.30E-13	62.2	0	0.69	7.57	0.047	6	56.55	+-	0.22
37	74.58	144.81	0.2395	0.02	0.11	0.18	0.21	5.90E-14	20.2	0	9.75	15.96	0.0031	2.7	57.95	+-	0.74
43	26.12	353.4	0.13347	0.1	0.25	0.13	1.46	3.80E-14	54.6	0	23.78	69.9	0.0011	1.5	64.66	+-	0.95
50	34.73	198.96	0.11481	0.1	1.19	1.61	2.96	1.10E-14	47	0	13.39	45.75	0.0021	0.4	65.2	+-	2.99
MD3	plag conc 250-500			J =	0.00193	+-	5.8E-06	(1 s.d.)		Exp. No.:	LC8F0117.IHD	Total gas age =			60.6	+-	0.2
13	123.23	13.032	0.3309	0.02	0.28	12.87	0.39	4.10E-14	21.5	0	0.88	1.04	0.037	1.7	90.75	+-	1.9
14	81.21	10.963	0.19522	0.07	0.55	29.9	1.32	1.90E-14	30	0	0.74	1.48	0.044	0.9	83.61	+-	3.04
15	54.78	10.844	0.11195	0.04	0.24	10.14	0.81	5.30E-14	41.2	0	0.73	2.56	0.045	2.7	77.47	+-	1.03
16	37.38	11.074	0.06157	0.03	0.11	4.93	0.78	9.40E-14	53.6	0	0.75	4.75	0.044	5.3	69.08	+-	0.49
17	27.55	12.932	0.03474	0.03	0.08	3.41	0.76	1.10E-13	66.4	0	0.87	9.83	0.038	6.6	63.2	+-	0.27
18	23.22	16.032	0.02389	0.02	0.09	3.19	1.47	8.80E-14	75	0	1.08	17.72	0.03	5.7	60.32	+-	0.31
19	21.17	22.49	0.02111	0.02	0.08	1.08	1.25	1.80E-13	78.8	0	1.51	28.13	0.021	12	58.09	+-	0.21
20	20.07	25.68	0.018571	0.03	0.1	1.43	1.61	1.20E-13	82.6	0	1.73	36.5	0.0188	7.9	57.87	+-	0.21
21	21.13	25.84	0.02173	0.03	0.09	1.14	1.12	1.50E-13	79.1	0	1.74	31.39	0.0186	10	58.35	+-	0.19
22.2	20.66	23.2	0.019907	0.03	0.06	1.29	1	1.40E-13	80.3	0	1.56	30.77	0.021	9.8	57.81	+-	0.16
23.5	20.81	19.967	0.019576	0.03	0.1	2	1.59	1.10E-13	79.7	0	1.34	26.93	0.024	7.3	57.66	+-	0.25
25	21.65	18.306	0.02122	0.03	0.1	2.41	1.53	9.90E-14	77.6	0	1.23	22.78	0.026	6.6	58.35	+-	0.27
27	22.05	17.027	0.0221	0.03	0.1	2.65	1.4	9.80E-14	76.4	0	1.15	20.34	0.028	6.6	58.45	+-	0.27
30	23.28	12.778	0.02524	0.04	0.09	3.1	1.02	1.10E-13	72.2	0	0.86	13.37	0.038	7.4	58.19	+-	0.25
33	30.58	19.239	0.0529	0.03	0.14	4.01	0.94	5.50E-14	53.8	0	1.29	9.6	0.025	3.8	57.16	+-	0.49
37	32.13	76.45	0.07413	0.07	0.31	3.93	1.84	3.30E-14	50.4	0	5.15	27.23	0.0061	2.2	58.52	+-	1.19
43	34.04	426.1	0.18247	0.03	0.2	0.4	0.88	4.90E-14	39.2	0	28.67	61.64	0.0008	2.9	64.12	+-	1.07
50	38.59	245.9	0.14825	0.13	0.7	2.06	2.22	1.10E-14	36.2	0	16.55	43.78	0.0017	0.7	57.39	+-	2.67

(a) Steps labeled either as temperature (deg C), laser power (W),or individual total fusion analyses (TF#).
(b) Corrected for 37Ar and 39Ar decay, half-lives 35.1 days and 259 years, respectively.
(c) Radiogenic (R), calcium-derived (Ca), and potassium-derived (K) argon, respectively (percent).
(d) Ages calculated relative to 85G003 TCR Sanidine at 27.92 Ma with lambda e = 0.581E-10/yr and lambda b = 4.692E-10/yr.

Results from Antrim

Step (a)	40Ar/39Ar (b)	37Ar/39Ar (b)	36Ar/39Ar (b)	40Ar s.d. (%)	39Ar s.d. (%)	37Ar s.d. (%)	36Ar s.d. (%)	40ArR (mol)	40ArR (c)	40ArK (c)	39ArCa (c)	36ArCa (c)	K/Ca (%)	39Ar (%)	Apparent Age (Ma)	+-	1 s.d. (Ma)
A2	wr lch 250-500			J =	0.00203	+-	6.1E-06	(1 s.d.)		Exp. No.:	F0110.IHD	Total gas age =			61.41	+-	0.2
13	28.91	0.7703	0.03598	0.04	0.2	34.58	0.97	7.90E-14	63.4	0	0.05	0.57	0.636	1.3	65.85	+-	0.42
14	23.79	1.1504	0.02004	0.03	0.16	13.37	1.22	9.40E-13	75.5	0	0.08	1.52	0.426	16.3	64.52	+-	0.29
15	21.6	1.1817	0.012267	0.04	0.08	18.13	2.39	6.70E-13	83.6	0	0.08	2.54	0.414	11.6	64.89	+-	0.3
16	21.16	2.22	0.011797	0.02	0.07	7.01	1.74	9.20E-13	84.3	0	0.15	4.97	0.22	16	64.16	+-	0.21
17.2	20.67	3.41	0.010318	0.05	0.11	6.83	3.22	6.20E-13	86.5	0	0.23	8.72	0.143	10.7	64.36	+-	0.33
18.5	19.338	5.446	0.009162	0.03	0.05	0.75	0.78	5.30E-13	88.2	0	0.37	15.69	0.09	9.7	61.5	+-	0.08
20	18.146	8.382	0.008286	0.05	0.05	0.46	0.7	5.60E-13	90.1	0	0.56	26.71	0.058	10.5	59.12	+-	0.07
21.5	17.792	9.96	0.008171	0.03	0.16	0.73	1.81	2.90E-13	90.8	0	0.67	32.18	0.049	5.5	58.48	+-	0.15
22.5	17.838	10.974	0.008655	0.03	0.17	0.74	1.77	2.30E-13	90.5	0	0.74	33.47	0.044	4.5	58.45	+-	0.16
23.7	17.625	12.099	0.009951	0.02	0.08	0.8	1.5	2.10E-13	88.7	0	0.81	32.1	0.04	4.1	56.69	+-	0.12
25	18.407	14.005	0.014063	0.05	0.14	0.85	1.42	1.60E-13	83.4	0	0.94	26.29	0.035	3.2	55.74	+-	0.19
27	18.778	15.48	0.018361	0.05	0.09	1.4	1.73	7.90E-14	77.5	0	1.04	22.26	0.031	1.7	52.99	+-	0.27
30	16.732	13.844	0.02029	0.04	0.16	1.46	1.92	6.90E-14	70.6	0.01	0.93	18.01	0.035	1.8	43.07	+-	0.35
35	18.426	91.07	0.04723	0.05	0.11	0.26	1.31	6.10E-14	62.8	0	6.13	50.91	0.0051	1.5	44.51	+-	0.36
43	18.514	204.5	0.07194	0.04	0.16	0.29	2.66	7.80E-14	71.3	0	13.76	75.05	0.0021	1.6	55.13	+-	0.62
PNB6	wr lch 250-500			J =	0.00196	+-	5.9E-06	(1 s.d.)		Exp. No.:	F0115.IHD	Total gas age =			62.44	+-	0.31
13	55.09	44.88	0.13489	0.05	0.28	2.46	1.34	2.10E-14	34	0	3.02	8.78	0.0106	3.5	67.12	+-	1.8
14	38.72	41.08	0.07405	0.1	0.46	3.65	3.54	1.70E-14	51.8	0	2.76	14.64	0.0116	2.6	71.56	+-	2.37
15	33.65	40.52	0.06009	0.09	0.27	2.84	3.86	2.10E-14	56.6	0	2.73	17.8	0.0118	3.3	68.07	+-	1.96
16.2	28.69	40.96	0.04683	0.11	0.18	1.41	2.63	4.30E-14	62.9	0	2.76	23.09	0.0116	7.3	64.55	+-	0.99
19	21	37.42	0.02336	0.04	0.09	0.75	3.08	7.60E-14	81	0	2.52	42.28	0.0128	13.9	60.77	+-	0.43
20.5	20.24	37.84	0.019359	0.04	0.15	1.17	7.14	5.30E-14	86.3	0	2.55	51.6	0.0126	9.4	62.4	+-	0.69
20.*	20.11	37.6	0.019825	0.04	0.14	1.17	7.83	5.30E-14	85.5	0	2.53	50.07	0.0127	9.5	61.39	+-	0.79
22	21.09	41.77	0.0255	0.03	0.09	0.52	2.86	1.00E-13	79.7	0	2.81	43.24	0.0114	19	60.22	+-	0.43
24	21.01	45.21	0.02486	0.04	0.14	0.93	4.58	5.40E-14	81.8	0	3.04	48.02	0.0105	9.7	61.71	+-	0.62
26	21.34	46.87	0.02603	0.04	0.19	1.05	5.13	4.60E-14	81.1	0	3.15	47.54	0.0101	8.2	62.19	+-	0.73
29	22.89	48.44	0.03119	0.08	0.27	1.49	5.35	3.30E-14	76.2	0	3.26	41	0.0098	5.8	62.77	+-	1.04
32	29.41	47.83	0.05327	0.11	0.29	2.75	4.69	1.70E-14	59.2	0	3.22	23.7	0.0099	3	62.57	+-	1.98
37	27.37	410.4	0.15809	0.17	0.32	0.23	2.69	1.80E-14	46.3	0	27.62	68.53	0.0009	3.2	60.94	+-	2.01
43	29.07	563.2	0.2043	0.17	0.67	0.33	4.53	1.00E-14	43.5	0	37.9	72.78	0.0005	1.6	70.68	+-	4.45
BVA0	wr lch 250-500			J =	0.00201	+-	0.000006	(1 s.d.)		Exp. No.:	F0111.IHD	Total gas age =			61.32	+-	0.2
13	118.84	11.252	0.3395	0.01	0.21	14.7	0.4	4.80E-14	16.3	0	0.76	0.87	0.043	1.5	69.43	+-	1.77
14	56.38	8.162	0.13066	0.02	0.08	7.15	0.27	1.30E-13	32.6	0	0.55	1.65	0.06	4.4	65.85	+-	0.46

15	38.54	7.062	0.06969	0.02	0.13	13.13	0.74	8.10E-14	48	0	0.48	2.68	0.069	2.8	66.12	+-	0.58
16	32.94	6.824	0.05301	0.02	0.09	6.41	0.53	1.70E-13	54.1	0	0.46	3.4	0.071	5.9	63.69	+-	0.32
17	27.75	6.125	0.03645	0.02	0.08	5.1	0.67	2.30E-13	62.9	0	0.41	4.44	0.08	8.3	62.43	+-	0.27
18	25.06	5.786	0.02767	0.02	0.06	4.68	0.66	2.60E-13	69.2	0	0.39	5.52	0.084	9.6	62	+-	0.2
19	22.66	6.055	0.02114	0.02	0.07	4.57	0.81	2.50E-13	74.5	0	0.41	7.56	0.081	9.3	60.43	+-	0.18
20	21.52	6.258	0.017252	0.02	0.09	4.31	0.94	2.60E-13	78.6	0	0.42	9.58	0.078	9.6	60.52	+-	0.17
21	20.16	6.532	0.012885	0.04	0.09	5.93	1.79	1.80E-13	83.6	0	0.44	13.38	0.075	6.6	60.37	+-	0.23
22.2	19.418	7.765	0.010904	0.03	0.08	5.61	2.61	1.60E-13	86.5	0	0.52	18.8	0.063	5.9	60.19	+-	0.25
23.5	19.244	10.093	0.011169	0.04	0.1	5.17	3.41	1.30E-13	86.9	0	0.68	23.86	0.048	4.9	60.04	+-	0.32
25	18.974	11.811	0.010578	0.03	0.1	3.35	2.81	1.70E-13	88.4	0	0.79	29.48	0.041	6.5	60.24	+-	0.24
27	19.01	12.468	0.01083	0.03	0.07	3.93	5.29	1.40E-13	88.3	0	0.84	30.39	0.039	5.3	60.31	+-	0.42
30	19.967	10.943	0.014178	0.03	0.15	5.69	2.79	1.10E-13	83.3	0	0.74	20.38	0.044	4.1	59.72	+-	0.35
33	21.68	10.774	0.02056	0.03	0.13	6.64	2.23	9.40E-14	75.8	0	0.73	13.83	0.045	3.6	59.04	+-	0.43
37	27.91	78.12	0.06119	0.02	0.07	0.57	0.58	1.50E-13	57	0	5.26	33.7	0.0059	5.5	59.89	+-	0.3
43	26.61	85.12	0.05841	0.03	0.07	0.47	0.65	1.70E-13	60.1	0	5.73	38.47	0.0054	6.2	60.45	+-	0.29
BVA3	wr lch 250-500			J =	0.00198	+-	0.000006	(1 s.d.)		Exp. No.: F0114.IHD		Total gas age =			60.74	+-	0.2
14	39.29	7.61	0.07415	0.05	0.07	0.57	0.92	9.90E-14	45.7	0	0.51	2.71	0.064	3.3	63.53	+-	0.69
15	26.81	7.194	0.03283	0.04	0.06	0.57	1.04	2.00E-13	65.9	0	0.48	5.79	0.068	6.7	62.44	+-	0.34
16	22.96	6.86	0.02076	0.06	0.06	0.28	1.2	2.60E-13	75.6	0	0.46	8.72	0.071	9.1	61.37	+-	0.24
17	21.27	6.785	0.015607	0.02	0.04	0.31	1.9	2.30E-13	80.8	0	0.46	11.48	0.072	8	60.76	+-	0.27
18	19.919	7.157	0.011782	0.01	0.04	0.12	1.01	5.60E-13	85.3	0	0.48	16.04	0.068	19.8	60.11	+-	0.11
19	18.91	7.415	0.008266	0.04	0.07	0.29	5.9	1.60E-13	90.1	0	0.5	23.68	0.066	5.6	60.29	+-	0.38
20	18.599	7.772	0.00756	0.02	0.07	0.24	3.99	2.60E-13	91.2	0	0.52	27.14	0.063	9.4	60.05	+-	0.23
21	18.689	7.671	0.007772	0.03	0.04	0.26	3.57	2.90E-13	90.9	0	0.52	26.05	0.064	10.2	60.11	+-	0.21
22.2	19.43	8.642	0.009813	0.03	0.07	0.25	4.26	1.80E-13	88.5	0	0.58	23.25	0.056	6.4	60.89	+-	0.33
23.5	20.22	10.161	0.0129	0.04	0.04	0.42	4.12	1.40E-13	85.1	0	0.68	20.79	0.048	4.9	60.93	+-	0.42
25	21.18	12.112	0.016748	0.05	0.1	0.42	3.88	1.10E-13	81.1	0	0.82	19.09	0.04	3.9	60.92	+-	0.53
27	22.58	14.176	0.02167	0.04	0.12	0.35	3.48	9.40E-14	76.5	0	0.95	17.27	0.034	3.3	61.38	+-	0.63
30	25.41	13.086	0.03156	0.03	0.09	0.43	2.37	9.00E-14	67.3	0	0.88	10.95	0.037	3.1	60.73	+-	0.68
33	31.91	14.776	0.05749	0.04	0.13	0.67	2.39	4.40E-14	50.4	0	0.99	6.79	0.033	1.6	57.18	+-	1.3
37	47.9	235.9	0.17749	0.04	0.11	0.08	0.82	5.10E-14	28.9	0	15.88	35.09	0.0017	1.9	58.01	+-	1.2
43	31.66	187.55	0.10336	0.15	0.36	0.13	1.24	8.60E-14	49.7	0	12.62	47.9	0.0023	2.9	63.37	+-	1
UBLFIBQ		wr lch		J =	0.00271	+-	0	(1 s.d.)		Exp. No.: F0019.IHD		Total gas age =			62.13	+-	0.12
12	73.7	3.949	0.17594	0.11	0.51	1.08	1.14	3.10E-14	29.9	0	0.27	0.59	0.124	1	104.88	+-	3.46
13	27.42	2.85	0.0371	0.35	0.67	2.05	6.97	1.80E-14	60.8	0	0.19	2.03	0.172	0.7	79.92	+-	3.58
14	21.26	2.663	0.02132	0.2	0.31	0.95	5.3	3.80E-14	71.3	0	0.18	3.3	0.184	1.8	72.83	+-	1.53
15	17.262	2.669	0.011225	0.1	0.13	0.39	3.89	9.40E-14	82	0	0.18	6.28	0.183	4.6	68.04	+-	0.58
16	15.743	2.66	0.008239	0.13	0.14	0.42	6.54	7.60E-14	85.8	0.01	0.18	8.52	0.184	3.9	65.03	+-	0.69
17	14.788	2.509	0.006099	0.08	0.09	0.24	3.95	1.70E-13	89.1	0.01	0.17	10.86	0.195	8.9	63.44	+-	0.31
18	14.12	2.349	0.004562	0.06	0.09	0.22	4.57	2.00E-13	91.7	0.01	0.16	13.59	0.208	10.6	62.37	+-	0.26
19	13.737	2.362	0.004026	0.07	0.07	0.22	6.2	1.60E-13	92.7	0.01	0.16	15.49	0.207	9	61.31	+-	0.3
20	13.645	2.428	0.004012	0.1	0.08	0.26	7.52	1.40E-13	92.7	0.01	0.16	15.98	0.201	7.4	60.92	+-	0.36

21.5	13.805	2.548	0.004708	0.07	0.08	0.2	4.62	1.80E-13	91.4	0.01	0.17	14.29	0.192	10.2	60.75	+-	0.27
23	13.812	2.644	0.004823	0.08	0.07	0.19	4.62	1.80E-13	91.2	0.01	0.18	14.47	0.185	10	60.66	+-	0.27
25	13.608	3.01	0.0043	0.07	0.1	0.2	5.57	1.70E-13	92.4	0.01	0.2	18.48	0.162	9.7	60.58	+-	0.28
28	13.724	3.955	0.005033	0.09	0.09	0.17	5.43	1.60E-13	91.4	0.01	0.27	20.74	0.124	8.8	60.49	+-	0.31
32	15.239	6.554	0.011332	0.09	0.11	0.11	2.66	1.40E-13	81.4	0.01	0.44	15.27	0.074	7.8	59.91	+-	0.37
37	16.641	10.1	0.018379	0.13	0.16	0.2	3.03	6.80E-14	72.1	0.01	0.68	14.51	0.048	4	58.13	+-	0.68
43	23.52	158.92	0.08864	0.19	0.36	0.05	2.54	2.40E-14	41.3	0	10.7	47.33	0.0028	1.5	52.48	+-	1.96
50	29.12	567.1	0.2313	0.58	1.89	0.07	5.37	3.10E-15	17.2	0	38.16	64.71	0.0005	0.3	39.1	+-	12.69
NEWBMQ		wr lch		J =	0.0027	+-	8.1E-06	(1 s.d.)		Exp. No.: F0022.IHD		Total gas age =			62.59	+-	0.23
12	184.81	5.884	0.5398	0.1	0.35	0.95	0.52	3.10E-14	13.9	0	0.4	0.29	0.083	0.9	121.72	+-	5.55
13	65.44	5.816	0.15922	0.7	0.87	2.38	4.25	8.60E-15	28.8	0	0.39	0.96	0.084	0.4	89.81	+-	9.84
14.2	46.47	5.157	0.10309	0.16	0.15	0.41	0.98	5.00E-14	35.3	0	0.35	1.32	0.095	2.3	78.39	+-	1.46
15.4	24.85	4.685	0.03653	0.18	0.1	0.29	1.83	6.90E-14	58	0	0.32	3.39	0.104	3.7	69.07	+-	0.92
16.5	18.4	4.456	0.015853	0.21	0.11	0.31	3.62	7.90E-14	76.4	0	0.3	7.42	0.11	4.3	67.37	+-	0.75
17.6	16.675	4.286	0.011833	0.19	0.11	0.24	4.27	9.00E-14	81	0.01	0.29	9.56	0.114	5.1	64.78	+-	0.65
18.7	15.59	4.201	0.009132	0.14	0.06	0.18	3.79	1.30E-13	84.8	0.01	0.28	12.15	0.116	7.6	63.39	+-	0.43
19.8	15.127	4.261	0.00849	0.13	0.07	0.16	3.43	1.50E-13	85.6	0.01	0.29	13.25	0.115	9.2	62.13	+-	0.36
21	15.4	4.227	0.0095	0.16	0.06	0.23	4.03	1.20E-13	83.9	0.01	0.28	11.75	0.116	7.1	61.99	+-	0.48
22.5	15.617	4.169	0.010608	0.14	0.06	0.19	3.12	1.30E-13	82	0.01	0.28	10.37	0.117	7.9	61.45	+-	0.42
24.5	14.516	4.107	0.007063	0.09	0.04	0.12	2.95	2.20E-13	87.8	0.01	0.28	15.35	0.119	13.1	61.17	+-	0.25
27	13.493	4.175	0.003954	0.11	0.05	0.19	6.21	2.10E-13	93.7	0.01	0.28	27.87	0.117	12.9	60.71	+-	0.26
31	13.806	5.497	0.005527	0.1	0.06	0.1	3.68	2.60E-13	91.3	0.01	0.37	26.26	0.089	15.6	60.53	+-	0.22
36	21.57	6.649	0.03327	0.12	0.08	0.17	1.15	1.10E-13	56.8	0	0.45	5.28	0.073	6.9	58.95	+-	0.53
42	32.04	81.04	0.09684	0.22	0.16	0.04	1.3	3.10E-14	30.4	0	5.45	22.09	0.0057	2.3	49.48	+-	1.52
50	19.314	662.3	0.2251	0.67	0.5	0.06	3.76	7.20E-15	23.2	0	44.57	77.69	0.0004	0.7	38.85	+-	5.35
GBY5		wr lch		J =	0.00271	+-	8.1E-06	(1 s.d.)		Exp. No.: F0027.IHD		Total gas age =			63.57	+-	0.23
12	71.58	8.832	0.16723	0.2	0.44	1.35	0.89	3.40E-14	31.9	0	0.59	1.39	0.055	1.4	108.98	+-	2.72
13	25.37	7.362	0.03091	0.87	0.61	2.52	7.93	1.60E-14	66.3	0	0.5	6.29	0.066	0.9	80.74	+-	3.36
14	21.38	7.168	0.02059	2.38	1.4	5.99	27.48	6.50E-15	74.2	0	0.48	9.19	0.068	0.4	76.21	+-	7.51
15.2	17.061	7.006	0.010811	0.18	0.15	0.33	3.03	1.10E-13	84.5	0.01	0.47	17.11	0.07	7.6	69.41	+-	0.42
16.2	15.13	6.863	0.00709	0.19	0.09	0.38	5.45	1.00E-13	89.7	0.01	0.46	25.55	0.071	7.2	65.42	+-	0.42
17.2	14.533	6.598	0.006481	0.16	0.08	0.3	4.82	1.20E-13	90.4	0.01	0.44	26.88	0.074	9	63.33	+-	0.34
18.3	14.226	6.551	0.006381	0.18	0.16	0.29	4.21	1.40E-13	90.3	0.01	0.44	27.1	0.074	10.7	62	+-	0.32
19.3	13.978	6.728	0.006009	0.14	0.08	0.25	4.68	1.40E-13	91	0.01	0.45	29.56	0.072	10.4	61.42	+-	0.29
20.4	13.95	7.114	0.006442	0.13	0.07	0.22	3.88	1.60E-13	90.3	0.01	0.48	29.15	0.069	12	60.84	+-	0.26
21.5	14.098	7.287	0.007155	0.14	0.1	0.26	3.98	1.30E-13	89	0.01	0.49	26.89	0.067	10.1	60.61	+-	0.31
22.7	14.266	7.504	0.00758	0.17	0.1	0.28	4.77	1.10E-13	88.4	0.01	0.51	26.14	0.065	8.3	60.9	+-	0.39
24	14.361	8.084	0.007923	0.24	0.17	0.35	5.87	8.20E-14	88.1	0.01	0.54	26.94	0.06	6.3	61.11	+-	0.51
26	14.431	9.411	0.008537	0.3	0.19	0.4	7.17	6.20E-14	87.6	0.01	0.63	29.1	0.052	4.7	61.13	+-	0.65
29	15.189	12.681	0.011704	0.22	0.12	0.25	4.14	8.00E-14	83.7	0.01	0.85	28.6	0.038	6.1	61.63	+-	0.51
33	20.26	18.939	0.03064	0.33	0.21	0.33	2.84	4.00E-14	62.6	0	1.27	16.32	0.026	3	61.71	+-	1.08
40	38.32	148.32	0.1228	0.31	0.38	0.08	1.46	2.40E-14	35.5	0	9.98	31.89	0.003	1.6	72.36	+-	2.19

50	44.43	843.9	0.3366	0.88	2.48	0.06	3.63	5.80E-15	24.3	0	56.79	66.18	0.0003	0.2	118.05	+-	20.31
AGH4	LAVA WR LCH			J =	0.0027	+-	8.1E-06	(1 s.d.)		Exp. No.: F0028.IHD		Total gas age =			61.4	+-	0.25
12	138.31	2.469	0.3707	0.19	0.96	8.32	1.32	2.40E-14	20.9	0	0.17	0.18	0.198	0.7	136.27	+-	10.01
13	26.78	2.579	0.02704	0.43	0.45	3.6	6.47	3.50E-14	70.9	0	0.17	2.52	0.19	1.5	90.47	+-	2.41
14	18.658	2.557	0.01036	0.4	0.31	2.4	10.66	4.90E-14	84.7	0	0.17	6.52	0.191	2.6	75.58	+-	1.46
15	16.617	2.567	0.007286	0.3	0.2	1.58	10.73	6.50E-14	88.2	0.01	0.17	9.3	0.191	3.8	70.27	+-	1
16	15.713	2.451	0.006906	0.48	0.53	3.02	17.77	4.70E-14	88.2	0.01	0.16	9.37	0.2	2.9	66.49	+-	1.59
17.5	15.147	2.787	0.006437	0.19	0.12	0.78	6.95	1.10E-13	88.9	0.01	0.19	11.43	0.175	6.7	64.62	+-	0.56
19	14.314	3.165	0.005708	0.13	0.07	0.4	4.33	1.90E-13	89.9	0.01	0.21	14.64	0.154	12.6	61.86	+-	0.31
20.2	13.502	3.356	0.004308	0.16	0.08	0.46	7.67	1.50E-13	92.5	0.01	0.23	20.57	0.146	10.1	60.05	+-	0.38
21.5	13.287	3.242	0.004149	0.16	0.11	0.44	7.33	1.60E-13	92.7	0.01	0.22	20.63	0.151	11.1	59.21	+-	0.35
22.7	13.066	2.927	0.003602	0.21	0.08	0.54	9.97	1.40E-13	93.6	0.01	0.2	21.45	0.167	9.4	58.8	+-	0.41
24	12.964	2.731	0.003428	0.13	0.09	0.43	7.93	1.80E-13	93.8	0.01	0.18	21.03	0.179	12.4	58.48	+-	0.31
26	13.006	2.771	0.003876	0.19	0.13	0.58	8.4	1.40E-13	92.8	0.01	0.19	18.87	0.177	10	58.07	+-	0.39
29	13.374	3.415	0.00529	0.16	0.1	0.47	6.52	1.30E-13	90.3	0.01	0.23	17.04	0.143	9.2	58.1	+-	0.41
33	14.573	5.794	0.010697	0.26	0.14	0.51	5.92	6.90E-14	81.4	0.01	0.39	14.3	0.084	4.9	57.18	+-	0.77
40	24.38	37.34	0.0574	0.38	0.4	0.22	2.98	2.30E-14	42.4	0	2.51	17.17	0.0128	1.9	50.99	+-	2.11
50	43.41	1245.1	0.4779	0.54	5.41	0.11	2.39	-6.20E-16	-1.6	0	83.8	68.78	0.0001	0.1	-20.68	+-	56.47
Tardree Rhyolite		Sanidine		J =	0.00093	+-	2.8E-06	(1 s.d.)		Exp. No.: L5057.IHD		Total gas age =			59.77	+-	0.2
2	42.08	0.016743	0.004848	0.48	0.73	86.78	51.83	2.50E-15	96.6	0	0	0.09	29.27	0.6	67.12	+-	1.37
2.3	36.19	0.04708	0.001927	0.36	0.51	25.36	101.16	2.90E-15	98.4	0	0	0.67	10.41	0.8	58.97	+-	1.03
2.5	35.87	0.0585	0.002443	0.76	0.54	18.85	131.48	2.00E-15	98	0	0	0.65	8.38	0.5	58.19	+-	1.67
2.7	36.36	0.04183	0.000431	0.4	0.65	13.5	203.69	6.20E-15	99.7	0	0	2.65	11.71	1.6	59.95	+-	0.63
3	36.57	0.03787	0.000879	0.27	0.74	11.55	78.23	7.00E-15	99.3	0	0	1.18	12.94	1.8	60.08	+-	0.59
3.3	36.25	0.03211	0.000016	0.17	0.28	10.42	%8600.32	1.00E-14	%100.0	0	0	54.23	15.26	2.7	59.98	+-	0.37
3.4	36.1	0.02348	0.000602	0.06	0.23	2.55	11.99	6.60E-14	99.5	0	0	1.06	20.87	16.9	59.45	+-	0.15
3.7	36.33	0.02368	0.000711	0.05	0.19	2.18	11.67	6.30E-14	99.4	0	0	0.91	20.69	16.2	59.76	+-	0.13
4.2	36.21	0.02359	0.000547	0.11	0.29	1.93	15.75	5.40E-14	99.6	0	0	1.18	20.77	13.9	59.66	+-	0.19
4.6	36.55	0.02154	0.000035	0.16	0.23	4.51	672.67	2.40E-14	%100.0	0	0	16.91	22.75	6.2	60.45	+-	0.2
10	36.16	0.02169	0.000183	0.09	0.33	1.66	24.13	1.50E-13	99.9	0	0	3.24	22.59	38.9	59.74	+-	0.21
Tardree		sanidine		J =	0.00095	+-	2.8E-06	(1 s.d.)		Exp. No.: L5067.IHD		Total gas age =			59.97	+-	0.19
3.3	38.58	0.02556	0.012756	0.2	0.22	14	5.64	7.90E-15	90.2	0	0	0.05	19.17	1.5	58.58	+-	0.41
3.7	36.25	0.02559	0.002657	0.16	0.38	13.21	20.42	1.50E-14	97.8	0	0	0.26	19.14	2.8	59.66	+-	0.37
4	35.97	0.02415	0.001245	0.07	0.23	4.86	12.54	4.30E-14	99	0	0	0.53	20.29	7.8	59.89	+-	0.17
4.3	36.18	0.02239	0.000877	0.06	0.19	2.86	11.52	5.80E-14	99.3	0	0	0.7	21.88	10.5	60.42	+-	0.13
4.6	35.67	0.01939	0.000042	0.11	0.12	0.91	56.04	2.00E-13	%100.0	0	0	12.47	25.27	36.1	59.99	+-	0.1
4.7	35.91	0.02036	0.001024	0.09	0.3	2.05	2.88	1.70E-13	99.2	0	0	0.54	24.07	31.4	59.89	+-	0.19
fuse	35.92	0.019242	0.000878	0.17	0.23	4.25	13.2	5.40E-14	99.3	0	0	0.6	25.46	9.9	59.98	+-	0.18
Tardree		sanidine		J =	0.00095	+-	2.8E-06	(1 s.d.)		Exp. No.: L5070.IHD		Total gas age =			60.51	+-	0.19

2.1	37.25	0.03656	0.004859	0.3	0.44	19.64	22.15	4.20E-15	96.2	0	0	0.21	13.4	1.4	60.25	+-	0.63
2.5	36.39	0.04316	0.005225	0.31	1.01	17.38	21.72	4.00E-15	95.8	0	0	0.23	11.35	1.4	58.64	+-	0.85
2.9	36.27	0.026	0.000769	0.04	0.19	1.34	5.87	9.40E-14	99.4	0	0	0.92	18.85	31.5	60.61	+-	0.12
3.2	36.18	0.02569	0.001309	0.09	0.25	4.9	16.85	2.60E-14	98.9	0	0	0.54	19.07	8.8	60.21	+-	0.2
3.7	36.12	0.0282	0.001007	0.09	0.36	3.59	10.84	4.60E-14	99.2	0	0	0.76	17.37	15.5	60.25	+-	0.23
3.8	36.19	0.0255	0.000368	0.04	0.17	2.03	21.94	1.20E-13	99.7	0	0	1.89	19.22	39.9	60.68	+-	0.12
4.4	36.34	0.008574	0.002893	0.41	0.76	149.35	86.03	2.70E-15	97.6	0	0	0.08	57.15	0.9	59.7	+-	1.34
fuse	37.32	0.04341	0.001839	0.71	0.72	52.79	197.89	1.90E-15	98.6	0	0	0.64	11.29	0.6	61.83	+-	1.89
Tardree		sanidine		J =	0.00094	+-	2.8E-06	(1 s.d.)		Exp. No.: L5080.IHD		Total gas age =			59.92	+-	0.19
1.6	44.26	0.007171	0.02033	0.2	0.28	30.81	7.5	7.80E-15	86.4	0	0	0.01	68.33	1.8	63.58	+-	0.79
2.2	39.96	0.02412	0.014261	0.2	0.43	24.18	11.53	7.50E-15	89.5	0	0	0.05	20.32	1.9	59.49	+-	0.87
2.6	36.37	0.02576	0.002231	0.13	0.39	12.06	37.54	1.20E-14	98.2	0	0	0.32	19.02	3.1	59.43	+-	0.48
2.9	36.56	0.02146	0.002264	0.14	0.44	11.09	37.13	1.20E-14	98.2	0	0	0.26	22.83	3	59.72	+-	0.5
3.2	36.68	0.01894	0.002041	0.07	0.16	9.16	21.84	2.40E-14	98.4	0	0	0.25	25.87	5.8	60.03	+-	0.24
3.5	36.57	0.0228	0.001968	0.06	0.22	3.94	17.87	3.00E-14	98.4	0	0	0.32	21.5	7.3	59.89	+-	0.22
4.1	36.52	0.0202	0.001084	0.03	0.17	3.35	20.72	5.50E-14	99.1	0	0	0.51	24.26	13.3	60.24	+-	0.15
4.6	36.45	0.02465	0.001401	0.05	0.17	2.71	27.73	2.90E-14	98.9	0	0	0.48	19.88	7	59.97	+-	0.22
5.3	36.69	0.02184	0.001882	0.04	0.14	2.37	11.59	5.00E-14	98.5	0	0	0.32	22.43	12.1	60.12	+-	0.14
fuse	36.1	0.018379	0.000825	0.03	0.12	2.08	9.05	1.80E-13	99.3	0	0	0.61	26.66	44.7	59.67	+-	0.09
Tardree		sanidine		J =	0.00093	+-	2.8E-06	(1 s.d.)		Exp. No.: L5144.IHD		Total gas age =			59.82	+-	0.19
2.1	39.46	0.0974	0.007448	0.2	0.41	20.13	11.46	7.40E-15	94.4	0	0.01	0.36	5.03	3.2	61.65	+-	0.5
2.5	36.95	0.04774	0.001735	0.13	0.35	32.87	27.38	1.20E-14	98.6	0	0	0.75	10.26	5.4	60.31	+-	0.32
2.9	36.64	0.03889	0.003132	0.15	0.45	34.37	19.07	9.90E-15	97.5	0	0	0.34	12.6	4.5	59.12	+-	0.4
3.3	36.54	0.03283	0.00132	0.14	0.26	15.85	18.36	2.30E-14	98.9	0	0	0.68	14.92	10.4	59.83	+-	0.21
3.7	36.24	0.02836	0.000737	0.1	0.11	6.79	8.49	7.60E-14	99.4	0	0	1.05	17.28	34.2	59.63	+-	0.1
4.1	36.17	0.03265	0.000729	0.07	0.2	11.9	17.12	3.70E-14	99.4	0	0	1.22	15.01	16.5	59.52	+-	0.14
4.3	36.53	0.02859	0.000682	0.07	0.17	10.25	16.24	5.00E-14	99.5	0	0	1.14	17.14	22.2	60.13	+-	0.13
fuse	39.14	0.09034	0.010825	0.14	0.21	15.68	5.15	8.20E-15	91.8	0	0.01	0.23	5.42	3.7	59.51	+-	0.31
Tardree		sanidine		J =	0.00094	+-	2.8E-06	(1 s.d.)		Exp. No.: L5145.IHD		Total gas age =			60.07	+-	0.18
2.1	37.91	0.09423	0.007109	0.29	0.71	26.17	12.8	4.70E-15	94.5	0	0.01	0.36	5.2	1.5	59.77	+-	0.65
2.4	36.08	0.07904	0.002754	0.16	0.44	21.27	25.08	7.10E-15	97.8	0	0.01	0.78	6.2	2.3	58.87	+-	0.43
2.5	36.01	0.02452	0.000375	0.06	0.16	8.48	14.74	9.40E-14	99.7	0	0	1.79	19.98	30.1	59.9	+-	0.11
2.6	36.37	0.02474	0.0005	0.09	0.16	8.54	22.23	6.20E-14	99.6	0	0	1.35	19.81	19.7	60.44	+-	0.12
2.9	36.14	0.02145	0.000417	0.04	0.17	11.72	18.1	6.00E-14	99.7	0	0	1.4	22.85	19.1	60.09	+-	0.11
fuse	36.25	0.02752	0.000848	0.08	0.07	5.75	7.96	8.60E-14	99.3	0	0	0.89	17.8	27.3	60.08	+-	0.08
y Breas obsidian		glass		J =	0.00094	+-	2.8E-06	(1 s.d.)		Exp. No.: L5059.IHD		Total gas age =			56.87	+-	0.24
3	35.46	0.06601	0.009663	0.28	0.43	0.46	1.21	2.80E-13	92	0	0	0.19	7.42	49.5	54.5	+-	0.31

3.2	36.28	0.06894	0.002705	0.11	0.31	1.51	3.73	2.40E-13	97.8	0	0	0.7	7.11	38.8	59.23	+-	0.21
3.3	38.44	0.0676	0.009603	0.13	0.32	3.38	3.26	2.20E-14	92.6	0	0	0.19	7.25	3.6	59.42	+-	0.27
3.4	40.62	0.07094	0.01692	0.16	0.38	2.23	2.32	1.10E-14	87.7	0	0	0.11	6.91	1.8	59.46	+-	0.34
3.7	44.19	0.06659	0.02931	0.21	0.94	9.94	3.27	4.40E-15	80.4	0	0	0.06	7.36	0.7	59.3	+-	0.86
4	42.85	0.06649	0.02617	0.22	0.39	7.39	3.34	5.20E-15	82	0	0	0.07	7.37	0.8	58.64	+-	0.54
5	40.92	0.06085	0.019233	0.17	0.4	3.82	2.83	7.60E-15	86.1	0	0	0.09	8.05	1.2	58.82	+-	0.4
7	41.32	0.05763	0.019418	0.15	0.43	8.53	2.76	7.50E-15	86.1	0	0	0.08	8.5	1.2	59.39	+-	0.41
9	41.04	0.06573	0.019388	0.19	0.38	4.35	3.48	9.30E-15	86.1	0	0	0.09	7.45	1.5	58.94	+-	0.44
fuse	45.73	0.07813	0.03885	0.31	0.45	9.76	3.74	4.20E-15	74.9	0	0.01	0.05	6.27	0.7	57.21	+-	0.84
y Breas obsidian		glass		J =	0.00095	+-	2.8E-06	(1 s.d.)		Exp. No.: L5060.IHD		Total gas age =			58.91	+-	0.18
1.7	45.21	0.0589	0.04956	0.2	0.42	2.53	1.28	1.60E-14	67.6	0	0	0.03	8.32	3.5	51.55	+-	0.49
1.9	35.78	0.06655	0.008254	0.2	0.17	1.83	1.91	5.10E-14	93.2	0	0	0.22	7.36	10.4	56.16	+-	0.18
2	35.67	0.06793	0.002618	0.11	0.08	0.62	3.67	9.30E-14	97.8	0	0	0.71	7.21	18.1	58.73	+-	0.1
2.1	36.08	0.06936	0.001886	0.04	0.19	0.79	4.29	7.10E-14	98.5	0	0	1	7.06	13.7	59.76	+-	0.13
2.2	35.84	0.06876	0.001709	0.08	0.1	0.55	3.19	1.40E-13	98.6	0	0	1.1	7.13	27.2	59.46	+-	0.08
2.3	36.5	0.06977	0.002413	0.07	0.08	0.67	3.63	7.10E-14	98.1	0	0	0.79	7.02	13.5	60.2	+-	0.08
2.4	37.01	0.07252	0.00428	0.09	0.21	2.77	7.3	2.30E-14	96.6	0	0.01	0.46	6.76	4.5	60.14	+-	0.21
2.6	36.8	0.0707	0.003509	0.07	0.27	3.48	10.65	2.10E-14	97.2	0	0	0.55	6.93	4.1	60.16	+-	0.25
3.3	37.33	0.07476	0.005802	0.11	0.22	2.95	6.37	1.40E-14	95.4	0	0.01	0.35	6.55	2.8	59.92	+-	0.24
4.1	38.7	0.09034	0.01174	0.25	0.77	6.49	11.56	3.80E-15	91.1	0	0.01	0.21	5.42	0.7	59.29	+-	0.85
fuse	38.74	0.09506	0.012527	0.17	0.4	5.55	6.97	7.80E-15	90.5	0	0.01	0.21	5.15	1.5	58.97	+-	0.52
Sandy Breas		Sanidine		J =	0.00094	+-	2.8E-06	(1 s.d.)		Exp. No.: L5058.IHD		Total gas age =			59.81	+-	0.2
2.5	66.72	0.03406	0.10393	0.12	0.44	10.97	0.81	8.80E-15	54	0	0	0.01	14.39	2.2	60.05	+-	0.7
2.9	35.05	0.018508	0.000478	0.19	0.45	18.95	101.56	7.30E-15	99.6	0	0	1.06	26.48	1.9	58.26	+-	0.37
3.3	36.51	0.02757	0.001343	0.19	0.53	10.36	45.62	9.50E-15	98.9	0	0	0.56	17.77	2.4	60.23	+-	0.46
3.4	35.77	0.01912	0.000399	0.14	0.21	6.51	38.61	3.50E-14	99.7	0	0	1.31	25.63	8.9	59.46	+-	0.17
3.8	35.8	0.02018	0.000106	0.12	0.36	3.39	122.61	4.10E-14	99.9	0	0	5.21	24.28	10.5	59.65	+-	0.23
4.2	36.49	0.018626	0.002629	0.09	0.33	3.11	5.46	5.10E-14	97.9	0	0	0.19	26.31	13	59.57	+-	0.23
5	35.98	0.021	0.000063	0.17	0.22	2.62	247.32	4.40E-14	%100.0	0	0	9.07	23.33	11.2	59.98	+-	0.18
5.6	35.99	0.01779	0.000134	0.04	0.23	1.37	20.94	2.00E-13	99.9	0	0	3.64	27.54	49.3	59.95	+-	0.14
10	47.13	0.016753	0.03765	0.5	0.97	72.1	4.48	2.60E-15	76.4	0	0	0.01	29.25	0.7	60.05	+-	1.21
Sandy Breas		sanidine		J =	0.00094	+-	2.8E-06	(1 s.d.)		Exp. No.: L5068.IHD		Total gas age =			60.05	+-	0.19
1.1	56.15	0.02242	0.05885	0.29	0.84	61.73	3.67	2.60E-15	69	0	0	0.01	21.86	0.9	64.39	+-	1.38
2.1	36.11	0.04511	0.001421	0.26	0.39	21.02	82.46	4.90E-15	98.8	0	0	0.87	10.86	1.8	59.37	+-	0.64
2.5	36.23	0.02324	0.000967	0.19	0.48	27.52	63.12	6.60E-15	99.2	0	0	0.66	21.09	2.4	59.79	+-	0.43
2.9	36.43	0.03278	0.001665	0.09	0.31	9.03	24	1.30E-14	98.7	0	0	0.54	14.95	4.6	59.78	+-	0.28
3.3	36.35	0.023	0.000817	0.05	0.14	3.59	12.04	5.40E-14	99.3	0	0	0.77	21.31	19.6	60.06	+-	0.11
3.6	36.27	0.0231	0.000803	0.03	0.16	2.94	11.6	4.90E-14	99.4	0	0	0.79	21.21	17.8	59.93	+-	0.11
4.2	36.49	0.02194	0.001712	0.05	0.26	6.33	9.11	3.60E-14	98.6	0	0	0.35	22.34	13.1	59.86	+-	0.18
4.7	36.37	0.02525	0.001305	0.08	0.26	5.1	19.41	2.20E-14	98.9	0	0	0.53	19.41	8.1	59.85	+-	0.21

fuse	36.39	0.02122	0.000615	0.03	0.1	2.31	11.17	8.70E-14	99.5	0	0	0.94	23.09	31.8	60.21	+-	0.08
Sandy Breas		sanidine		J =	0.00095	+-	2.9E-06	(1 s.d.)		Exp. No.: L5069.IHD		Total gas age =			60.56	+-	0.19
2.6	37.5	0.02666	0.005144	0.11	0.3	9.56	6.37	1.20E-14	96	0	0	0.14	18.38	4.1	60.77	+-	0.26
3	36.05	0.018122	0.001179	0.22	0.54	43.36	77.14	9.40E-15	99	0	0	0.42	27.04	3.1	60.31	+-	0.57
3.3	36.08	0.02063	0.001161	0.05	0.15	6.28	14.92	2.70E-14	99.1	0	0	0.49	23.76	9	60.37	+-	0.13
3.6	36.16	0.018811	0.001474	0.07	0.23	10.72	15.94	2.00E-14	98.8	0	0	0.35	26.05	6.7	60.35	+-	0.19
4	36.03	0.02119	0.001152	0.05	0.23	4.31	11.89	3.50E-14	99.1	0	0	0.5	23.13	11.7	60.29	+-	0.16
4.5	36.26	0.019798	0.00122	0.07	0.22	6.24	16.5	2.70E-14	99	0	0	0.44	24.75	9.1	60.65	+-	0.17
5	36.25	0.02076	0.001603	0.11	0.31	7.2	15.14	2.50E-14	98.7	0	0	0.35	23.61	8.2	60.44	+-	0.23
fuse	36.13	0.017857	0.000687	0.05	0.13	2.46	5.05	1.50E-13	99.4	0	0	0.71	27.44	48.1	60.68	+-	0.09
Sandy Breas		sanidine		J =	0.00094	+-	2.8E-06	(1 s.d.)		Exp. No.: L5081.IHD		Total gas age =			60.02	+-	0.2
2.5	42.56	0.02458	0.017476	0.2	0.39	14.4	9.89	7.70E-15	87.9	0	0	0.04	19.93	2.4	62.33	+-	0.91
2.9	36.04	0.017222	0.001194	0.28	0.5	19.33	100.89	6.00E-15	99	0	0	0.39	28.45	2	59.52	+-	0.69
3	35.94	0.016517	0.000026	0.16	0.22	12.97	%3597.37	1.30E-14	%100.0	0	0	17.05	29.67	4.4	59.94	+-	0.42
3.4	36.03	0.014903	0.000665	0.22	0.52	16.92	276.74	6.20E-15	99.5	0	0	0.61	32.88	2	59.76	+-	0.96
3.9	36.3	0.02349	0.00046	0.19	0.51	14.12	272.34	8.50E-15	99.6	0	0	1.4	20.86	2.8	60.31	+-	0.69
4.5	37.08	0.014612	0.004807	0.25	0.55	13.59	39.36	5.80E-15	96.2	0	0	0.08	33.53	1.9	59.48	+-	1
4.9	36.21	0.019705	0.002159	0.1	0.28	5.14	12.83	3.70E-14	98.2	0	0	0.25	24.87	12.2	59.35	+-	0.23
5.5	36.43	0.014193	0.000417	0.05	0.26	4.71	70.8	3.80E-14	99.7	0	0	0.93	34.52	12.4	60.55	+-	0.22
8	36	0.015324	0.000111	0.07	0.18	3.12	60.79	1.70E-13	99.9	0	0	3.76	31.97	56.9	59.99	+-	0.12
fuse	36.51	0.019822	0.001525	0.2	0.5	14.68	77.66	9.00E-15	98.8	0	0	0.35	24.72	2.9	60.14	+-	0.67
Sandy Breas		sanidine		J =	0.00095	+-	2.8E-06	(1 s.d.)		Exp. No.: L5139.IHD		Total gas age =			59.97	+-	0.19
1.7	44.48	0.03354	0.02364	0.41	1	167.86	9.19	2.10E-15	84.3	0	0	0.04	14.61	0.6	62.96	+-	1.31
1.8	35.86	0.04126	0.001775	0.2	0.54	56.48	42.15	5.20E-15	98.5	0	0	0.63	11.87	1.7	59.38	+-	0.49
2.2	36.56	0.04247	0.002827	0.13	0.29	29.3	14.94	9.90E-15	97.7	0	0	0.41	11.54	3.1	60.03	+-	0.28
2.7	36.52	0.04496	0.003151	0.16	0.56	35.24	16.1	7.80E-15	97.5	0	0	0.39	10.9	2.5	59.81	+-	0.42
3	36.45	0.03103	0.001817	0.11	0.4	28.65	15.41	1.70E-14	98.5	0	0	0.47	15.79	5.5	60.34	+-	0.28
3.5	36.03	0.03228	0.001145	0.06	0.24	12.99	13.27	2.80E-14	99.1	0	0	0.77	15.18	8.7	59.96	+-	0.16
4	35.8	0.02753	0.000618	0.06	0.16	6.51	8.02	8.90E-14	99.5	0	0	1.22	17.8	28.3	59.85	+-	0.11
4.2	35.81	0.02283	0.000628	0.08	0.23	4.22	5.58	1.30E-13	99.5	0	0	0.99	21.46	40.8	59.86	+-	0.14
fuse	36.34	0.014536	0.001041	0.12	0.17	32.32	15.11	2.80E-14	99.2	0	0	0.38	33.71	8.7	60.54	+-	0.15
Sandy Breas		Sanidine		J =	0.00095	+-	2.8E-06	(1 s.d.)		Exp. No.: L5148.IHD		Total gas age =			60.43	+-	0.19
1.7	45.08	0.10502	0.02502	0.32	0.8	49.53	8.14	2.80E-15	83.6	0	0.01	0.11	4.67	0.7	63.33	+-	1.16
1.8	36.91	0.04332	0.002319	0.2	0.71	26.63	38.59	6.10E-15	98.2	0	0	0.51	11.31	1.7	60.9	+-	0.62
1.9	37.03	0.019264	0.003338	0.2	0.35	100.19	25.08	6.40E-15	97.3	0	0	0.16	25.44	1.8	60.59	+-	0.47
2.1	37.06	0.03928	0.003147	0.3	0.61	83.1	45.43	3.70E-15	97.5	0	0	0.34	12.47	1	60.74	+-	0.8
2.2	36.33	0.018495	0.001687	0.17	0.19	63.86	30.22	1.10E-14	98.6	0	0	0.3	26.49	3	60.25	+-	0.29
2.7	36.11	0.02254	0.000888	0.07	0.11	14.82	9.35	6.40E-14	99.3	0	0	0.69	21.73	17.7	60.28	+-	0.09

2.9	36.14	0.016936	0.000855	0.06	0.23	8	12.12	5.10E-14	99.3	0	0	0.54	28.93	14.1	60.33	+-	0.15
3	36.19	0.015925	0.001071	0.08	0.13	15.8	11.88	4.40E-14	99.1	0	0	0.41	30.77	12.1	60.32	+-	0.11
3.4	36.09	0.02227	0.000415	0.07	0.14	4.03	13.08	1.50E-13	99.7	0	0	1.47	22	41.6	60.48	+-	0.1
4	36.66	0.03223	0.00189	0.12	0.44	17.87	16.73	1.70E-14	98.5	0	0	0.47	15.2	4.7	60.69	+-	0.31
10	39.15	0.06458	0.011191	0.23	0.39	22.75	7.81	6.10E-15	91.6	0	0	0.16	7.59	1.7	60.27	+-	0.51
Mourne G1		Biotite		J =	0.00094	+-	2.8E-06	(1 s.d.)		Exp. No.: L5104.IHD		Total gas age =			54.82	+-	0.23
0.8	74.21	0.011999	0.14548	0.09	0.26	49.87	1.03	8.80E-15	42.1	0	0	0	40.84	10.4	51.93	+-	0.83
1	20.05	0.7847	0.02453	12.94	2.14	53.27	101.4	5.20E-17	64.2	0	0.05	0.87	0.624	0.1	21.59	+-	12.93
1.2	330.1	9.309	0.4521	5.56	15.95	29.19	66.4	1.20E-16	59.8	0	0.65	0.56	0.052	0	307.3	+-	152.3
1.4	37.43	0.19114	0.019538	1.76	1.67	55.23	40.46	5.30E-16	84.6	0	0.01	0.27	2.56	0.6	52.67	+-	4.1
1.6	39.93	0.03485	0.02177	0.24	0.4	40.03	5.97	4.20E-15	83.9	0	0	0.04	14.06	4.6	55.66	+-	0.7
1.8	38.21	0.008811	0.015921	0.12	0.3	29.41	4.95	1.30E-14	87.7	0	0	0.02	55.61	14	55.67	+-	0.43
2	36.25	0.00573	0.01013	0.1	0.22	44.64	2.53	2.40E-14	91.7	0	0	0.02	85.52	26.5	55.26	+-	0.19
2.2	35.83	0.005275	0.008877	0.17	0.32	31.48	3.17	2.90E-14	92.7	0	0	0.02	92.89	31.9	55.18	+-	0.25
2.6	35.72	0.005388	0.008623	0.17	0.51	100	4.72	1.00E-14	92.9	0	0	0.02	90.94	11.3	55.12	+-	0.37
3	44.04	0.7208	0.08319	2.13	2.46	18.6	11.94	2.20E-16	44.3	0	0.05	0.24	0.679	0.4	32.65	+-	5.5
fuse	51.18	-0.352864	0.10991	5.61	3.69	%-116.84	35.93	7.00E-17	36.5	0	-0.02	-0.09	%-1.3890	0.1	31.23	+-	20.29
Mourne G1		Biotite		J =	0.00094	+-	2.8E-06	(1 s.d.)		Exp. No.: L5105.IHD		Total gas age =			55.19	+-	0.2
1.4	75.51	0.004071	0.14757	0.09	0.16	100	0.84	6.60E-15	42.3	0	0	0	120.4	6.5	53.05	+-	0.67
1.6	40.67	0.009896	0.03088	0.49	0.44	376.3	15.32	1.70E-15	77.6	0	0	0.01	49.51	1.7	52.46	+-	2.33
1.8	38.17	0.007591	0.016411	0.11	0.13	31.24	2.84	1.70E-14	87.3	0	0	0.01	64.55	15.5	55.37	+-	0.25
2	36.42	0.007661	0.010287	0.28	0.58	121.14	14.9	4.60E-15	91.7	0	0	0.02	63.96	4.3	55.46	+-	0.83
2.2	35.17	0.004123	0.006255	0.07	0.2	29	2.57	4.80E-14	94.7	0	0	0.02	118.9	45.1	55.36	+-	0.15
2.6	34.18	0.002718	0.002886	0.1	0.1	65.68	11.47	2.70E-14	97.5	0	0	0.03	180.3	25.5	55.38	+-	0.18
fuse	40.34	0.03126	0.02117	0.63	1.16	117.87	23.77	1.40E-15	84.5	0	0	0.04	15.67	1.3	56.62	+-	2.58
Mourne G1		biotite		J =	0.00094	+-	2.8E-06	(1 s.d.)		Exp. No.: L5112.IHD		Total gas age =			55.86	+-	0.24
1.7	46.49	-0.010859	0.03711	0.5	1.06	-41.83	3.18	1.70E-14	76.4	0	0	-0.01	%-45.1262	13.1	59.17	+-	1.07
1.9	34.42	0.007778	0.004557	0.19	0.56	81.55	13.63	1.10E-14	96.1	0	0	0.05	63	9.2	55.15	+-	0.45
2.1	34.13	0.009722	0.002368	0.29	0.37	34.78	10.69	2.20E-14	98	0	0	0.11	50.4	18.1	55.74	+-	0.29
2.2	34.11	0.013531	0.00287	0.18	0.37	22.24	8.37	2.40E-14	97.5	0	0	0.13	36.21	19.7	55.47	+-	0.26
2.3	34.6	0.011643	0.003812	0.18	0.41	81.53	13.09	1.10E-14	96.7	0	0	0.08	42.09	8.8	55.8	+-	0.35
2.6	34.62	0.00622	0.004893	0.19	0.35	106.66	6.39	1.50E-14	95.8	0	0	0.03	78.78	12.4	55.31	+-	0.27
3	34.37	0.001711	0.004884	0.13	0.35	470.07	5.55	1.20E-14	95.8	0	0	0.01	286.4	10.2	54.9	+-	0.25
fuse	34.22	0.02096	0.004827	0.21	0.37	28.68	8.19	1.00E-14	95.8	0	0	0.12	23.38	8.4	54.69	+-	0.31
Mourne G1		biotite		J =	0.00094	+-	2.8E-06	(1 s.d.)		Exp. No.: L5115.IHD		Total gas age =			56.66	+-	0.35
1.5	72.97	0.03494	0.1301	0.24	0.51	124.07	2.57	2.30E-15	47.3	0	0	0.01	14.02	6.7	57.54	+-	1.78
1.8	37.13	0.013623	0.010522	0.21	0.29	100	11.74	5.50E-15	91.6	0	0	0.04	35.97	16.1	56.7	+-	0.64
2	39.48	0.06716	0.013857	0.92	1.36	100	41.22	1.20E-15	89.6	0	0	0.13	7.3	3.3	58.95	+-	2.95

2.2	36.21	0.003351	0.008909	0.14	0.19	273.53	12.46	7.60E-15	92.7	0	0	0.01	146.2	22.6	55.97	+-	0.55
2.6	37.33	0.008081	0.012049	0.12	0.5	%-140.38	6.17	9.20E-15	90.5	0	0	0.02	60.63	27.1	56.29	+-	0.48
3	36.62	0.008193	0.009454	0.18	0.37	186.69	12.71	5.80E-15	92.4	0	0	0.02	59.81	17	56.39	+-	0.63
3.4	47.94	0.14029	0.03637	1.52	0.86	100	33.59	5.80E-16	77.6	0	0.01	0.11	3.49	1.6	61.92	+-	6.04
fuse	39.76	0.0385	0.016486	0.5	0.4	100	19.43	2.00E-15	87.8	0	0	0.06	12.73	5.7	58.13	+-	1.6

(a) Steps labeled either as temperature (deg C), laser power (W),or individual total fusion analyses (TF#).
(b) Corrected for 37Ar and 39Ar decay, half-lives 35.1 days and 259 years, respectively.
(c) Radiogenic (R), calcium-derived (Ca), and potassium-derived (K) argon, respectively (percent).
(d) Ages calculated relative to 85G003 TCR Sanidine at 27.92 Ma with lambda e = 0.581E-10/yr and lambda b = 4.692E-10/yr.

Results Ardnamurchan

Step (a)	40Ar/39Ar (b)	37Ar/39Ar (b)	36Ar/39Ar (b)	40Ar s.d. (%)	39Ar s.d. (%)	37Ar s.d. (%)	36Ar s.d. (%)	40ArR (mol)	40ArR (c)	40ArK (c)	39ArCa (c)	36ArCa (c)	K/Ca (%)	39Ar (%)	Apparent Age (Ma)	+-	1 s.d. (Ma)
AN20		WR LCH		J =	0.00271 +-			8.1E-06 (1 s.d.)		Exp. No.:	LC9I0034.IHD		Total gas age =		61.13	+-	0.19
12	73.93	1.7842	0.19117	0.11	0.16	1.92	0.45	2.50E-14	23.8	0	0.12	0.25	0.274	0.3	84.09	+-	1.46
13	57.21	1.9337	0.1381	0.1	0.34	3.34	0.91	1.30E-14	28.9	0	0.13	0.37	0.253	0.2	79.29	+-	2.06
14	38.73	1.7838	0.07867	0.12	0.3	2.19	1.03	2.10E-14	40.3	0	0.12	0.6	0.274	0.3	74.9	+-	1.3
15	23.61	1.5108	0.03102	0.11	0.15	0.61	0.66	8.30E-14	61.7	0	0.1	1.29	0.324	1.2	69.91	+-	0.36
16	18.03	1.168	0.014366	0.15	0.1	0.56	0.79	1.30E-13	77	0	0.08	2.15	0.419	2	66.66	+-	0.22
17	16.987	1.029	0.01138	0.17	0.12	1.28	2.06	5.60E-14	80.7	0.01	0.07	2.39	0.476	0.8	65.85	+-	0.35
18.5	15.497	1.0356	0.007207	0.1	0.14	1.5	3.67	2.80E-13	86.8	0.01	0.07	3.79	0.473	4.3	64.64	+-	0.37
20	15.077	0.8721	0.005946	0.2	0.16	1.55	4.11	4.90E-14	88.8	0.01	0.06	3.87	0.562	0.7	64.35	+-	0.37
21.5	14.604	0.9858	0.004846	0.18	0.11	0.49	1.53	1.70E-13	90.7	0.01	0.07	5.37	0.497	2.6	63.7	+-	0.18
22.5	13.597	1.2945	0.003213	0.19	0.21	0.53	2.73	8.70E-13	93.8	0.01	0.09	10.64	0.378	14	61.34	+-	0.22
23	12.674	2.25	0.00126	0.15	0.1	0.42	24.68	4.70E-13	98.4	0.01	0.15	47.16	0.217	7.8	60.1	+-	0.25
23.5	12.697	3.019	0.002235	0.15	0.09	0.23	3.38	2.30E-13	96.6	0.01	0.2	35.65	0.162	3.9	59.15	+-	0.13
24.5	12.869	3.509	0.003043	0.21	0.14	0.18	2.37	2.20E-13	95.1	0.01	0.24	30.44	0.139	3.6	59.04	+-	0.17
25.5	12.89	3.949	0.003629	0.22	0.17	0.19	1.93	3.50E-13	94.1	0.01	0.27	28.73	0.124	5.9	58.5	+-	0.19
26	12.685	3.819	0.002479	0.21	0.13	0.16	4.66	1.70E-13	96.6	0.01	0.26	40.68	0.128	2.8	59.08	+-	0.18
27	12.89	4.199	0.003216	0.2	0.11	0.06	1.93	2.60E-13	95.2	0.01	0.28	34.47	0.116	4.4	59.18	+-	0.15
28	12.904	4.209	0.003376	0.1	0.09	0.18	2.68	1.80E-13	94.8	0.01	0.28	32.91	0.116	3	59.02	+-	0.12
29.5	12.93	4.059	0.003424	0.03	0.1	0.32	6.95	3.80E-13	94.6	0.01	0.27	31.29	0.12	6.4	59.02	+-	0.23
31	13.371	2.901	0.004402	0.14	0.11	0.19	2.08	1.60E-13	92	0.01	0.2	17.4	0.169	2.6	59.27	+-	0.16
33	13.623	2.355	0.005288	0.16	0.13	0.23	1.47	1.90E-13	89.9	0.01	0.16	11.76	0.208	3.2	59	+-	0.17
36	14.419	1.6022	0.007488	0.03	0.06	0.29	1.07	1.10E-12	85.5	0.01	0.11	5.65	0.305	17.7	59.38	+-	0.12
42	17.36	11.87	0.017416	0.03	0.08	0.1	0.83	7.10E-13	75.7	0	0.8	17.99	0.041	11	63.64	+-	0.19
50	25.9	128.62	0.07251	0.11	0.13	0.1	0.42	1.20E-13	56	0	8.66	46.83	0.0035	1.5	76.05	+-	0.41
Ardnamuchan (AN11)		biotite		J =	0.00094 +-			2.8E-06 (1 s.d.)		Exp. No.:	LC9L5073.IHD		Total gas age =		58.7	+-	0.26
0.5	182.51	0.09085	0.5308	0.73	1.05	61.96	1.75	9.70E-16	14.1	0	0.01	0	5.39	1.5	42.93	+-	6.57
1.3	132.75	0.3017	0.336	0.68	2.37	29.63	5.94	4.00E-16	25.2	0	0.02	0.02	1.624	0.5	55.85	+-	11.73
1.4	53.65	0.2275	0.05714	0.6	1.35	11.96	11.06	1.30E-15	68.6	0	0.02	0.11	2.15	1.4	61.24	+-	3.34
1.7	44.69	0.3035	0.018718	1.42	1.81	21.74	72.04	7.20E-16	87.7	0	0.02	0.44	1.614	0.7	65.17	+-	6.69
1.8	40.28	0.0345	0.014186	0.3	0.26	34.53	12.45	4.80E-15	89.6	0	0	0.07	14.2	5.3	60.09	+-	0.89
2.1	36.2	0.04538	0.002803	0.28	0.55	24.44	84.04	4.30E-15	97.7	0	0	0.44	10.8	4.9	58.93	+-	1.19
2.5	36.79	0.008192	0.00262	0.25	0.75	80.95	54.82	6.50E-15	97.9	0	0	0.09	59.81	7.2	59.98	+-	0.84
2.9	36.59	0.012832	0.004359	0.06	0.25	13.66	10.01	2.40E-14	96.5	0	0	0.08	38.19	27.8	58.8	+-	0.26
3.4	36.2	0.008945	0.003388	0.09	0.16	7.67	6.26	4.40E-14	97.2	0	0	0.07	54.78	50.7	58.63	+-	0.15
Ardnamuchan (AN11)		biotite		J =	0.00094 +-			2.8E-06 (1 s.d.)		Exp. No.:	LC9L5074.IHD		Total gas age =		45.73	+-	0.16

2.1	60.89	0.04727	0.10317	0.21	0.35	18.08	1.65	4.70E-15	49.9	0	0	0.01	10.37	2.9	50.77 +-	0.95
2.5	30.38	0.007496	0.005828	0.15	0.21	20.06	8.62	1.40E-14	94.3	0	0	0.04	65.36	9.4	47.88 +-	0.28
2.8	24.64	0.003272	0.002345	0.12	0.15	64.62	8.34	2.60E-14	97.2	0	0	0.04	149.7	20.7	40.1 +-	0.13
3	29.39	0.005446	0.002915	0.16	0.2	14.94	5.16	3.50E-14	97.1	0	0	0.05	89.97	23.2	47.67 +-	0.15
3.2	27.25	0.006731	0.001913	0.12	0.22	19.27	11.16	2.40E-14	97.9	0	0	0.1	72.8	17	44.62 +-	0.16
3.4	29.2	0.005261	0.002496	0.18	0.25	32.52	15.3	1.80E-14	97.5	0	0	0.06	93.14	11.9	47.55 +-	0.24
3.8	31.73	0.006109	0.002978	0.27	0.33	30.97	10.48	1.90E-14	97.2	0	0	0.06	80.21	11.8	51.5 +-	0.27
4.2	21.79	0.05754	0.007727	0.66	0.79	11.19	31.54	1.70E-15	89.5	0	0	0.2	8.52	1.6	32.74 +-	1.25
fuse	23.31	0.02068	0.005385	0.82	0.99	37.41	52.28	1.70E-15	93.2	0	0	0.1	23.69	1.5	36.4 +-	1.47
Ardnamuchan (AN11)	biotite		J =	0.00094 +-		2.8E-06 (1 s.d.)			Exp. No.:	LC9L5075.IHD		Total gas age =			58.4 +-	0.24
1.9	112.53	0.15476	0.2721	0.2	0.95	11.63	1.33	2.70E-15	28.6	0	0.01	0.02	3.17	3.1	53.51 +-	2.82
2.2	41.5	0.018491	0.02136	0.3	0.7	24.21	8.03	5.90E-15	84.8	0	0	0.02	26.5	6.2	58.5 +-	0.98
2.6	38.39	0.005982	0.00913	0.1	0.41	30.77	5.04	1.60E-14	93	0	0	0.02	81.91	16.2	59.32 +-	0.35
2.9	36.51	0.000713	0.0051	0.25	0.43	480.35	21.53	8.50E-15	95.9	0	0	0	687.4	8.9	58.2 +-	0.61
3.2	37.29	0.008796	0.007987	0.13	0.38	13.18	5.07	1.90E-14	93.7	0	0	0.03	55.71	20.2	58.07 +-	0.31
3.5	38.57	0.001312	0.010819	0.17	0.2	115.1	4.12	2.00E-14	91.7	0	0	0	373.5	20.6	58.8 +-	0.28
3.9	36.6	0.014672	0.006391	0.28	0.39	18.91	10.32	1.10E-14	94.8	0	0	0.06	33.4	11.7	57.73 +-	0.43
fuse	38.69	0.015821	0.01085	0.16	0.38	11.99	5.95	1.30E-14	91.7	0	0	0.04	30.97	13.1	58.98 +-	0.41
AN11	biotite		J =	0.00094 +-		2.8E-06 (1 s.d.)			Exp. No.:	LC9L5078.IHD		Total gas age =			60.05 +-	0.4
1.7	117.24	0.12852	0.2638	0.32	1.18	16.93	4.23	1.80E-15	33.5	0	0.01	0.01	3.81	2.4	65.61 +-	6.07
2	44.78	0.03884	0.02684	0.21	0.66	14.46	12.76	5.40E-15	82.3	0	0	0.04	12.62	7.7	61.58 +-	1.73
2.2	37.89	0.03353	0.006688	0.21	0.29	14.61	31.73	7.80E-15	94.8	0	0	0.14	14.61	11.4	60.04 +-	1.05
2.5	39.45	0.019248	0.007888	0.43	0.83	89.73	86.54	2.50E-15	94.1	0	0	0.07	25.46	3.5	62.02 +-	3.35
2.9	38.81	0.013143	0.00813	0.27	0.37	46.93	31.64	6.90E-15	93.8	0	0	0.04	37.28	9.9	60.84 +-	1.28
3.3	36.98	0.010893	0.005134	0.16	0.31	17.2	19.29	1.70E-14	95.9	0	0	0.06	44.98	25	59.29 +-	0.52
3.7	37.14	0.014209	0.003157	0.22	0.27	34.14	56.83	9.80E-15	97.5	0	0	0.12	34.48	14.1	60.51 +-	0.89
fuse	36.27	0.09841	0.003326	0.14	0.16	2.07	29.22	1.80E-14	97.3	0	0.01	0.81	4.98	26.1	59.01 +-	0.48

(a) Steps labeled either as temperature (deg C), laser power (W),or individual total fusion analyses (TF#).
(b) Corrected for 37Ar and 39Ar decay, half-lives 35.1 days and 259 years, respectively.
(c) Radiogenic (R), calcium-derived (Ca), and potassium-derived (K) argon, respectively (percent).
(d) Ages calculated relative to 85G003 TCR Sanidine at 27.92 Ma with lambda e = 0.581E-10/yr and lambda b = 4.692E-10/yr.

Results Arran

Step (a)	40Ar/39Ar (b)	37Ar/39Ar (b)	36Ar/39Ar (b)	40Ar s.d. (%)	39Ar s.d. (%)	37Ar s.d. (%)	36Ar s.d. (%)	40ArR (mol)	40ArR (c)	40ArK (c)	39ArCa (c)	36ArCa (c)	K/Ca (%)	39Ar (%)	Apparent Age (Ma)	+-	1 s.d. (Ma)
Arran granite		Biotite		J =	0.000942 +-		2.8E-06 (1 s.d.)			Exp. No.:	LC9L5063.IHD		Total gas age =		56.64	+-	0.25
1.3	163.89	0.04354	0.4816	0.14	0.65	26.66	0.99	1.80E-15	13.2	0	0	0	11.25	2.9	36.29	+-	3.43
1.5	37.02	0.00927	0.009038	0.11	0.3	8.24	4.1	2.20E-14	92.8	0	0	0.03	52.86	22.1	57.46	+-	0.27
1.7	44.15	0.02473	0.03639	0.31	0.78	13.43	3.06	8.90E-15	75.6	0	0	0.02	19.81	9.4	55.87	+-	0.84
1.9	35.95	0.005906	0.005723	0.16	0.27	21.98	5.2	2.40E-14	95.3	0	0	0.03	82.96	24.7	57.3	+-	0.24
2.2	35.63	0.000148	0.004391	0.17	0.43	%1014.33	7.64	2.40E-14	96.4	0	0	0	3300	24.2	57.41	+-	0.32
2.6	35.33	0.012044	0.004145	0.18	0.85	14.11	16.41	1.00E-14	96.5	0	0	0.08	40.68	10.4	57.05	+-	0.62
fuse	36.72	0.05351	0.007041	0.31	0.3	9.22	16.63	6.10E-15	94.3	0	0	0.21	9.16	6.2	57.93	+-	0.64
Arran granite		biotite		J =	0.000942 +-		2.8E-06 (1 s.d.)			Exp. No.:	LC9L5076.IHD		Total gas age =		57.6	+-	0.36
1.4	72.76	0.006693	0.13727	0.14	0.4	55.07	1.1	9.50E-15	44.3	0	0	0	73.21	22.9	53.91	+-	0.94
1.7	39.35	0.017136	0.015063	0.33	0.52	40.01	9.16	6.10E-15	88.7	0	0	0.03	28.59	13.6	58.35	+-	0.78
2	39.67	0.012647	0.015129	0.27	0.34	18.48	3.89	1.40E-14	88.7	0	0	0.02	38.74	30.5	58.84	+-	0.4
2.3	36.78	0.003646	0.006739	0.28	0.51	127.48	13.75	8.70E-15	94.6	0	0	0.01	134.4	19.5	58.18	+-	0.57
2.6	37.09	0.03239	0.005845	0.4	0.79	23.86	33.13	4.20E-15	95.3	0	0	0.15	15.13	9.2	59.12	+-	1.08
3	40.51	0.02405	0.015257	1.13	0.91	69.71	28.32	2.00E-15	88.9	0	0	0.04	20.38	4.3	60.16	+-	2.3
Arran granite		biotite		J =	0.000938 +-		2.8E-06 (1 s.d.)			Exp. No.:	LC9L5077.IHD		Total gas age =		57.92	+-	0.27
1.4	71.63	0.007133	0.12828	0.07	0.46	53.82	1.27	1.30E-14	47.1	0	0	0	68.69	11.1	56.2	+-	1.01
1.8	36.49	0.005151	0.005529	0.09	0.19	26.69	12.42	2.30E-14	95.5	0	0	0.03	95.12	19.8	58.06	+-	0.36
2.1	37.72	0.012077	0.009425	0.1	0.16	18.65	13.72	1.30E-14	92.6	0	0	0.03	40.57	10.9	58.18	+-	0.64
2.5	41.9	0.004416	0.0222	0.15	0.29	55.61	6.27	1.20E-14	84.3	0	0	0.01	111	9.8	58.85	+-	0.71
2.8	36.4	0.004465	0.005416	0.05	0.22	26.41	9.73	3.00E-14	95.6	0	0	0.02	109.7	25.7	57.97	+-	0.29
3.2	36.89	0.004486	0.005871	0.14	0.43	83.83	28.51	9.40E-15	95.3	0	0	0.02	109.2	7.9	58.55	+-	0.86
fuse	35.81	0.005449	0.003741	0.13	0.16	43.3	24.73	1.70E-14	96.9	0	0	0.04	89.93	14.8	57.81	+-	0.46

(a) Steps labeled either as temperature (deg C), laser power (W),or individual total fusion analyses (TF#).
(b) Corrected for 37Ar and 39Ar decay, half-lives 35.1 days and 259 years, respectively.
(c) Radiogenic (R), calcium-derived (Ca), and potassium-derived (K) argon, respectively (percent).
(d) Ages calculated relative to 85G003 TCR Sanidine at 27.92 Ma with lambda e = 0.581E-10/yr and lambda b = 4.692E-10/yr.

Results from West of Shetland and Anglesey

Step (a)	40Ar/39Ar (b)	37Ar/39Ar (b)	36Ar/39Ar (b)	40Ar s.d. (%)	39Ar s.d. (%)	37Ar s.d. (%)	36Ar s.d. (%)	40ArR (mol)	40ArR (c)	40ArK (c)	39ArCa (c)	36ArCa (c)	K/Ca (%)	39Ar (%)	Apparent Age (Ma)	+-	1 s.d. (Ma)
57-12/18		wr lch 250-500		J =	0.001917 +-		5.8E-06 (1 s.d.)			Exp. No.:	LC8F0040.IHD		Total gas age =		47.86	+-	0.15
Anton Dorhn																	
15	85.57	3.306	0.2245	0.74	2.05	37.92	7.15	1.80E-15	22.8	0	0.22	0.39	0.148	0	66.27	+-	16.99
16	63.99	1.1156	0.16542	0.21	0.08	3.64	0.33	4.50E-14	23.7	0	0.08	0.18	0.439	0.8	51.82	+-	0.76
17	55.55	1.6624	0.12361	0.08	0.14	1.21	0.28	1.40E-13	34.5	0	0.11	0.36	0.294	2	65.13	+-	0.51
18	41.09	1.3454	0.1001	0.45	0.28	13.8	1.15	9.30E-15	28.3	0	0.09	0.35	0.364	0.2	39.78	+-	1.36
19.5	44.98	1.748	0.09375	0.06	0.25	1.81	0.41	7.70E-14	38.7	0	0.12	0.49	0.28	1.2	59.31	+-	0.6
21	42.47	1.9416	0.08138	0.08	0.18	1	0.29	9.50E-14	43.7	0	0.13	0.63	0.252	1.3	63.2	+-	0.41
22.5	17.462	2.469	0.009788	0.03	0.06	0.16	0.37	1.10E-12	84.5	0	0.17	6.66	0.198	19.3	50.42	+-	0.06
24	14.799	3.405	0.003708	0.08	0.08	0.33	3.35	1.70E-12	94.4	0.01	0.23	24.25	0.144	31.8	47.78	+-	0.11
26	14.635	5.23	0.003546	0.03	0.06	0.11	2.5	3.70E-13	95.6	0.01	0.35	38.94	0.093	6.9	47.93	+-	0.07
28.5	14.427	5.88	0.004202	0.07	0.06	0.08	1.99	6.20E-13	94.6	0.01	0.4	36.94	0.083	11.8	46.76	+-	0.07
31	13.764	6.179	0.003885	0.04	0.08	0.11	2.12	4.50E-13	95.2	0.01	0.42	41.99	0.079	8.8	44.92	+-	0.06
34	12.508	4.784	0.003654	0.07	0.04	0.12	1.49	4.70E-13	94.3	0.01	0.32	34.57	0.102	10.3	40.48	+-	0.05
37	16.9	12.491	0.016147	0.07	0.06	0.19	0.93	1.10E-13	77.5	0.01	0.84	20.42	0.039	2.2	45.13	+-	0.13
43	47.46	76.39	0.13479	0.08	0.1	0.07	0.18	1.90E-13	28.6	0	5.14	14.96	0.0061	3.4	48.88	+-	0.4
57-13/66		wr lch		J =	0.001942 +-		5.8E-06 (1 s.d.)			Exp. No.:	LC8F0041.IHD		Total gas age =		58.27	+-	0.21
18	91.5	5.115	0.2429	0.09	0.37	4.98	0.82	2.30E-14	22	0	0.34	0.56	0.095	0.5	69.39	+-	2.39
20	26.2	4.927	0.02485	0.08	0.18	1.69	2.01	5.00E-13	73.4	0	0.33	5.23	0.099	11.7	66.4	+-	0.49
21.5	19.159	5.694	0.005136	0.08	0.1	1.02	9.15	6.80E-13	94.4	0	0.38	29.26	0.086	16.9	62.5	+-	0.33
23	18.423	6.46	0.005458	0.06	0.05	0.51	4.27	1.90E-13	94	0	0.43	31.25	0.076	5	59.91	+-	0.16
25	18.042	7.108	0.005747	0.05	0.12	0.24	2.1	3.60E-13	93.7	0	0.48	32.65	0.069	9.5	58.52	+-	0.11
27	17.889	7.958	0.007266	0.07	0.08	0.11	0.72	8.50E-13	91.5	0	0.54	28.91	0.061	23.4	56.73	+-	0.08
29	17.019	8.655	0.006227	0.07	0.1	0.63	7.69	6.40E-13	93.1	0.01	0.58	36.69	0.056	18.3	55.02	+-	0.3
31	17.977	10.51	0.010534	0.07	0.12	0.35	2.49	1.70E-13	87.2	0	0.71	26.34	0.046	4.8	54.5	+-	0.21
35	20.5	10.754	0.02302	0.03	0.09	0.4	1	1.70E-13	70.9	0	0.72	12.33	0.045	5.2	50.56	+-	0.21
43	37.93	201.9	0.13774	0.09	0.4	0.13	1.31	1.50E-13	34.2	0	13.59	38.7	0.0021	4.6	51.87	+-	1.47
57-12/18		wr lch		J =	0.002694 +-		8.1E-06 (1 s.d.)			Exp. No.:	LC9F0029.IHD		Total gas age =		54.01	+-	0.17
Anton Dorhn																	
12	61.67	2.055	0.13715	0.39	0.48	6.04	2.54	1.90E-14	34.5	0	0.14	0.4	0.238	0.3	100.78	+-	5
13	35.74	1.8753	0.06791	0.09	0.07	0.77	0.62	1.20E-13	44.3	0	0.13	0.73	0.261	2.1	75.35	+-	0.62
14	15.62	1.9922	0.010475	0.17	0.08	0.7	3.9	9.90E-14	81.2	0.01	0.13	5.02	0.246	2.3	60.67	+-	0.55
15	12.117	1.8303	0.002766	0.17	0.13	0.45	9.31	1.60E-13	94.4	0.01	0.12	17.47	0.267	4	54.83	+-	0.32
16	11.476	1.6296	0.001853	0.13	0.09	0.52	14.63	1.60E-13	96.3	0.01	0.11	23.22	0.3	4.1	53	+-	0.3
17	11.173	1.485	0.001654	0.12	0.05	0.4	12.42	2.10E-13	96.7	0.01	0.1	23.7	0.33	5.5	51.79	+-	0.23
18	11.065	1.3688	0.001304	0.16	0.07	0.6	23.65	1.40E-13	97.5	0.01	0.09	27.72	0.358	3.8	51.72	+-	0.32

19.1	11.088	1.5649	0.001551	0.04	0.03	0.24	7.84	3.80E-13	97	0.01	0.11	26.63	0.313	10.2	51.56 +-	0.13
20	10.846	1.9204	0.00136	0.1	0.08	0.33	15.22	2.40E-13	97.7	0.01	0.13	37.28	0.255	6.5	50.83 +-	0.19
21	10.792	2.503	0.001521	0.1	0.12	0.25	13.03	2.80E-13	97.6	0.01	0.17	43.45	0.195	7.6	50.58 +-	0.17
22	10.711	3.286	0.001673	0.05	0.06	0.11	11.23	3.60E-13	97.8	0.01	0.22	51.85	0.149	10	50.3 +-	0.13
23	10.505	3.948	0.00154	0.14	0.15	0.29	37.74	1.60E-13	98.6	0.01	0.27	67.68	0.124	4.5	49.77 +-	0.28
24.2	10.466	4.824	0.001771	0.13	0.07	0.21	35.83	1.70E-13	98.6	0.01	0.32	71.93	0.101	4.7	49.62 +-	0.25
25.5	10.423	5.678	0.002162	0.15	0.1	0.19	30.51	1.50E-13	98.1	0.01	0.38	69.32	0.086	4.2	49.21 +-	0.29
27	10.228	6.507	0.002558	0.14	0.09	0.15	21.14	1.60E-13	97.6	0.01	0.44	67.15	0.075	4.7	48.06 +-	0.26
29	10.003	7.007	0.002853	0.14	0.11	0.12	18.53	1.50E-13	97	0.01	0.47	64.83	0.07	4.5	46.78 +-	0.27
32	10.386	6.886	0.003616	0.11	0.07	0.13	7.88	2.10E-13	94.9	0.01	0.46	50.28	0.071	6	47.48 +-	0.21
37	14.173	6.16	0.007221	0.03	0.07	0.16	2.77	2.60E-13	88.3	0.01	0.41	22.52	0.079	6.1	60.08 +-	0.22
43	16.863	37.5	0.01673	0.02	0.06	0.1	1.95	3.70E-13	88	0.01	2.52	59.18	0.0127	6.9	72.53 +-	0.2
50	20.17	13.547	0.015775	0.16	0.1	0.26	3.46	1.20E-13	82.1	0	0.91	22.67	0.036	2	79.46 +-	0.6
3317	WR.LCH		J =		0.002698 +-		8.1E-06 (1 s.d.)			Exp. No.:	LC9F0042.IHD		Total gas age =		67.61 +-	0.37
12	164.83	10.263	0.4985	0.05	0.9	1.7	1.62	7.70E-15	11.1	0	0.69	0.54	0.047	0.4	87.62 +-	14.22
13.5	49.73	9.76	0.11841	0.06	0.48	1.01	3.67	1.20E-14	31.2	0	0.66	2.18	0.05	0.7	74.4 +-	5.93
15	27.49	9.359	0.046	0.07	0.2	0.48	4.12	2.80E-14	53.2	0	0.63	5.37	0.052	1.8	70.26 +-	2.45
16.5	20.53	11.129	0.02415	0.03	0.09	0.21	3.53	6.40E-14	69.5	0	0.75	12.16	0.044	4.2	68.62 +-	1.03
18	15.677	16.946	0.012618	0.07	0.12	0.2	12.49	2.60E-13	84.6	0.01	1.14	35.45	0.029	18.4	64.17 +-	1.4
18.5	14.353	17.434	0.009468	0.04	0.12	0.13	12.03	7.40E-14	90	0.01	1.17	48.61	0.028	5.4	62.51 +-	0.81
19.5	14.367	16.443	0.00935	0.03	0.11	0.16	10.42	8.20E-14	89.7	0.01	1.11	46.43	0.029	6	62.33 +-	0.72
20.5	16.289	14.891	0.015326	0.03	0.08	0.1	3.6	1.10E-13	79.3	0.01	1	25.65	0.033	7.8	62.43 +-	0.57
21.5	14.807	13.28	0.009653	0.05	0.08	0.18	10.77	6.50E-14	87.7	0.01	0.89	36.32	0.037	4.7	62.69 +-	0.91
23	16.931	11.273	0.015053	0.02	0.1	0.18	3.46	1.10E-13	78.9	0.01	0.76	19.77	0.043	7.8	64.37 +-	0.58
24.5	20.06	9.341	0.02408	0.04	0.13	0.25	3.14	6.90E-14	68.2	0	0.63	10.24	0.052	4.7	65.76 +-	0.94
26.5	21.75	7.634	0.02794	0.02	0.1	0.14	1.6	1.20E-13	64.8	0	0.51	7.21	0.064	7.8	67.64 +-	0.58
29.5	17.481	6.831	0.013644	0.06	0.16	0.52	12.06	3.30E-14	80	0	0.46	13.22	0.071	2.2	67.1 +-	1.94
34	19.263	5.352	0.016932	0.03	0.07	0.2	2.19	1.50E-13	76.2	0	0.36	8.34	0.091	9.8	70.3 +-	0.47
40	20.14	3.679	0.017367	0.01	0.08	0.22	1.78	1.80E-13	75.9	0	0.25	5.59	0.133	11.1	73.11 +-	0.41
50	28.85	20.81	0.04497	0.02	0.08	0.07	1.12	1.30E-13	59.6	0	1.4	12.22	0.023	7.2	82.91 +-	0.63

(a) Steps labeled either as temperature (deg C), laser power (W),or individual total fusion analyses (TF#).
(b) Corrected for 37Ar and 39Ar decay, half-lives 35.1 days and 259 years, respectively.
(c) Radiogenic (R), calcium-derived (Ca), and potassium-derived (K) argon, respectively (percent).
(d) Ages calculated relative to 85G003 TCR Sanidine at 27.92 Ma with lambda e = 0.581E-10/yr and lambda b = 4.692E-10/yr.

Sample	Irradiation	Vial	Colleted by	Location
MT2	EK29	A	LMC	Muck
MT3	EK29	A	LMC	Muck
LB1	EK29	B	LMC	Mull
BM67	EK29	B	Kerr, 1993	Mull
BM64	EK29	B	Kerr, 1993	Mull
MD1	EK29	B	LMC	Mull
MD2	EK29	B	LMC	Mull
MD3	EK29	B	LMC	Mull
SO33	EK29	B	Dagley et al. 1987	Mull
SO17	EK29	B	Dagley et al. 1987	Mull
BB6	EK29	B	Kerr, 1993	Mull
B1	EK29	B	LMC	Mull
T3	EK29	B	Kerr, 1993	Mull
T1	EK29	B	Kerr, 1993	Mull
MKD1	EK29	D	LMC	Muck
A2	EK29	D	Wallace, 1995	Antrim
BVA0	EK29	D	Wallace, 1995	Antrim
BVA3	EK29	D	Wallace, 1995	Antrim
PNB6	EK29	D	Wallace, 1995	Antrim
57/12-18	EK29	D	LMC	BGS
58/13-66	EK29	D	LMC	BGS

Irradiation	Vial	Location	Sample No	Prep	Notes	Collected By
EK33	C	Skye	SG16/Sg16	arfedsonite	Loch Ainort granite (R)	
EK33	C	Skye	SG19	arfedsonite	Glas Beinn More (R)	
EK33	C	Skye	SG32	arfedsonite	Marsco granite (N)	
EK33	C	Skye	SG27	arfedsonite	Glamaich granite (N)	
EK33	C	Skye	SG36/SG59	Riebeckite	Rudha Stac granite (R)	
EK33	C	Rum	SR475	hornblende	central complex	Emeleus, 1997
EK33	C	Rum	SR534	hornblende	central complex	Emeleus, 1997
EK33	C	Skye	U031/U112	hornblende	Coire Unagneich (N)	Dagley et al, 1990
EK33	C	Skye	U117	hornblende	Beinn an Dubhaich (R)	Dagley et al, 1990
EK33	C	Skye	SD3	wr lch	dyke cuts lava	
EK33	C	Rum	SR215	wr lch	upper basalt	Dagley and Mussett, 1981
EK33	C	Skye	SB10	wr lch	middle basalt	
EK33	C	Skye	SB3	wr lch	lower basalt	
EK33	C	Skye	SD1	wr lch	dyke cuts lava	
EK33	C	Skye	SK139	wr lch	upper/middle basalt	B Bell
EK33	C	Offshore	Anton Dorhn	wr harsh lch	lava	BGS
EK33	C	Anglesea	3317	wr lch	dyke	R Bevins
EK33	C	Anglesea	3208	wr lch	dyke	R Bevins
EK33	C	Antrim	AGH4	wr lch	Upper basalt	Wallace,1995
EK33	C	Antrim	Dyke BMQ	wr lch	dyke cuts lava	
EK33	C	Antrim	GBY5	wr lch	Lower basalt	Wallace,1995
EK33	C	Antrim	NEWBMQ	wr lch	Lower basalt	
EK33	C	Antrim	UBLFIBQ	wr lch	Upper basalt	
EK33	C	Ardnamurchan	AN20	wr lch	cone sheet (C1)	
EK33	D	Ardnamurchan	AN21	wr lch	lava	
EK33	D	Ardnamurchan	AN22	wr lch	lava	
EK33	D	Ardnamurchan	AN26	wr lch	cone sheet (C3)	
EK33	D	Arran	AL1	wr lch	Lava	
EK33	D	Arran	AL2	wr lch	Lava	
EK33	D	Arran	P008	wr lch	dyke (R)	Hodgson et al, 1990
EK33	D	Arran	P014	wr lch	dyke (N)	Hodgson et al, 1990
EK33	D	Muck	T601	wr lch	dyke	Dagley and Mussett, 1986
EK33	D	Rum	SR187	wr lch	middle basalt	Dagley and Mussett, 1981
EK33	D	Rum	T161	wr lch	coastal dyke	Dagley and Mussett, 1981
EK33	D	Rum	T173	wr lch	coastal dyke	Dagley and Mussett, 1981
EK33	D	Rum	T402D	wr lch	dyke cuts lava (R)	Dagley and Mussett, 1981
EK33	D	Rum	T418D	wr lch	dyke cuts lava (N)	Dagley and Mussett, 1981
EK33	D	Skye	SB11	wr lch	middle basalt	
EK33	D	Skye	SG61	wr lch	Upper basalt	
EK33	D	Skye	SG62B	wr lch	Preshal More	
EK33	D	Skye	SG69	wr lch	Preshal Beg	
EK33	D	Skye	SG9	wr lch	dyke cuts last granite (R)	
EK33	D	Skye	SKB1	wr lch	Lower basalt	
EK33	B	Skye	U034	wr lch	middle dyke	Dagley et al, 1990
EK33	B	Arran	AD84	f gmass	dyke	Hodgson et al, 1990
EK33	B	Offshore	HTN	f gmass	lava	BGS
EK33	B	Rum	SR157	f gmass	Lower basalt	Emeleus, 1997
EK33	B	Skye	ST1	f gmass	lower basalt	
EK33	B	Muck	T695	plag sep	dyke	Dagley and Mussett, 1986
EK33	B	Rum	SR190	plag sep	middle basalt	Dagley and Mussett, 1981
EK33	B	Skye	PT1	plag sep	Lowest lava	
EK33	B	Skye	U034	wr lch	middle dyke	Dagley et al, 1990
EK33	B	Arran	AD84	f gmass	dyke	Hodgson et al, 1990
EK33	B	Offshore	HTN	f gmass	lava	BGS
EK33	B	Rum	SR157	f gmass	Lower basalt	Emeleus, 1997
EK33	B	Skye	ST1	f gmass	lower basalt	
EK33	B	Muck	T695	plag sep	dyke	Dagley and Mussett, 1986
EK33	B	Rum	SR190	plag sep	middle basalt	Dagley and Mussett, 1981
EK33	B	Skye	PT1	plag sep	Lowest lava	
EK33	A	Eigg	T908	wr core	lava	Dagley and Mussett, 1986
EK33	A	Muck	T752	wr core	lava	Dagley and Mussett, 1986
EK33	A	Canna	SR252	wr core	Lava	Dagley and Mussett, 1981
EK33	A	Skye	SK137	wr core	upper/middle basalt	B Bell
EK33	A	Skye	SK167	wr core felsic	Upper basalt	B Bell
EK33	A	Antrim	G1	biotite	Mourne	I Meighan
EK33	A	Antrim	G5	biotite	Mourne	I Meighan
EK33	A	Ardnamurchan	AN11	biotite	Biotite gabbro (C3)	
EK33	A	Ardnamurchan	AN12	biotite	central complex (C3)	
EK33	A	Arran	A2	biotite	inner granite (N)	
EK33	A	Arran	A3	biotite	outer granite (N)	
EK33	A	Arran	A9	biotite	central complex	
EK33	A	Antrim	SBO	K spar	Sandy Breas Obsidian	I Meighan
EK33	A	Antrim	TR	K spar	Tardree rhyolite	I Meighan

Collected by LMC unless stated

Sample No.	Irradiation	Pan	Hole	Location	Mineral	Notes	Collected by
SR475	EK35	C	1-9	Rum	hornblende	central complex	Emeleus, 1997
SR534	EK35	C	10-17	Rum	hornblende	central complex	Emeleus, 1997
SG19	EK35	C	19-26	Skye	hornblende	Glas Beinn More	LMC
SG16	EK35	C	27-35	Skye	hornblende	Loch Ainhort granite	LMC
SG32	EK35	D	1-9	Skye	hornblende	Marsco granite	LMC
SG27	EK35	D	10-17	Skye	arfedsonite	Glamaich granite	LMC
U117	EK35	D	19-26	Skye	biotite	Beinn an Dubhaich	Dagley et al, 1990
G1	EK35	D	27-35	Antrim	biotite	mourne	I Meighan
SG59	EK35	E	1-9	Skye	Riebeckite	Rudah Stac granite	LMC
TR	EK35	E	10-17	Antrim	sanidine	Tardree rhyolite	I Meighan
SBO	EK35	E	19-26	Antrim	glass	Sandy Breas Obsidian	I Meighan
SBO	EK35	E	27-35	Antrim	sanidine	Sandy Breas Obsidian	I Meighan
E3	EK35	F	1-9	Eigg	sanidine	Pitchstone	LMC
E3	EK35	F	10-17	Eigg	glass	Pitchstone	LMC
AN11	EK35	F	19-26	Ardnamurchan	biotite	Biotite eucrite C3	LMC
A3	EK35	F	27-35	Arran	biotite	outer granite	LMC

Appendix C

C1 Sample lists

C2 XRF results

C3 $\delta^{18}O$ results

Island	Location	Sample No.	Grid Ref.	Rock Type	Notes
Muck	Camas Mor	MKD1	407793	basalt	dyke
		M2	414787	gabbro	dyke with metic aureole
		M3	414787	basalt	
		M4	415787	basalt	above M3
		MT1	418785	tuff	lower
		M6	418785	basalt	above M5
		MT2	418785	tuff	upper
		M8	418785	basalt	above M7
	harbour	M9	426791	basalt	below M9
		MT3	426791	tuff	
		M11	426791	basalt	above M9
Eigg	An Sgurr	EP	loose block	pitchstone	

Island	Location	Sample No.	Grid Ref.	Rock Type	Notes	Collected by
Mull	Loch Ba	LB1		felsite	ring dyke in gully	LMC
		LB2		felsite	50m NW of gully	LMC
		M13		basalt	cuts dolerite and Loch Ba	LMC
		MD1		basalt	Dyke Cuts Loch Ba	LMC
		E001-E010		basalt	Dyke Cuts Loch Ba	Dagley et al, 1987
	Centre 1	SO17		basalt	Central Group Normal polarity	Dagley et al, 1987
		SO31		basalt	Central Group Normal polarity	Dagley et al, 1987
		SO33		basalt	Central Group Normal polarity	Dagley et al, 1987
		SO34		basalt	Central Group Normal polarity	Dagley et al, 1987
		SO38		basalt	Central Group Normal polarity	Dagley et al, 1987

Island	Location	Sample No.	Grid Ref.	Rock Type
Arnamurchan	Loch Mudle	AN1	541655	basalt
	Loch Mudle	AN2	538663	basalt
	Loch Mudle	AN3	538666	basalt
	nr Achnosnich	AN4	442678	eucrite
	nr Achnosnich	AN5	447667	eucrite
	ridge	AN6	473662	eucrite
	Sanna	AN7	446694	gabbro
	ridge	AN8	454691	gabbro
		AN9	457688	
	nr Achnaha	AN10	463683	
	after achnaha	AN11	466680	
		AN12	467678	
		AN13	472673	gabbro
	Ard.Point	AN14	417673	gabbro
	Ard.Point	AN15	423669	gabbro
	Ard.Point	AN16	424670	gabbro
	Ard.Point	AN17	424674	gabbro
	Ard.Point	AN18	427672	gabbro
	after Kildonan	AN19	505640	basalt
	Quarry	AN20	512648	basalt
		AN21	513651	basalt
	nr T junction	AN22	518658	basalt
		AN23	521659	basalt
	nr Braehouse	AN24	527674	basalt
	turning to Faskadale	AN25	514700	basalt
	nr Faskadele	AN26	507706	basalt

Island	Location	No.	Grid Ref.	Rock Type	Sample dir.	Dyke dir.
Arran	Catacol	A1	923470	granite	347/60e	
		A2	923470	granite	007/84e	
		A3	922480	granite	164/78e	
		A4	922480	granite	242/76se	
	Tormore	AD1	883313	dyke	191/87w	229/70w
		AD2	883313	dyke	227/80w	048/80w
		AD3	884309	dyke	033/50w	029/64w
		AD4	885307	dyke	310/90v	030/74w
		AD5	885307	dyke	256/70e	064/70e
		AD6	867306	dyke	017/84w	080/60e
	Blackwaterfoot	AD7	867306	dyke	134/84ne	054/30se
	S of Whiting Bay	AD8	GR052240	dyke	229/52ne	343/82e
		AD9		dyke	344/60e	342/60e
		AD10		dyke	347/44s	126/74se
		AD11		dyke	035/76se	325/70w
		AD12		dyke	223/86w	307/70e
		AD13	GR050247	dyke	322/88e	307/70e
		AD14	GR049250	dyke	034/84se	330/75e
		AD15	"	dyke	300/43e	320/62e
		AD16	"	dyke	058/42se	320/62e
	Layby	A5	GR050229	dyke	134/76e	
	Kildonan	AD17	GR007208	dyke	330/70w	348/74w
		AD18		dyke	280/76w	008/90v
		AD19		dyke	192/80w	202/74e
		AD20		dyke	184/84e	200/74e
		AD21		dyke	347/88w	348/80w
		AD22		dyke	220/80e	136/70ne
		AD23		dyke	092/88s	002/90v
		AD24		dyke	354/74e	010/70w
		AD25		dyke	166/82e	178/72e
		AD26		dyke	322/74e	136/44w
		AD27		dyke	230/90v	330/70w
		AD28		dyke	204/74e	"
		AD29		dyke	308/76w	"
		AD30		dyke	232/66s	"
		AD31		dyke	238/72se	"
		AD32		dyke	336/44e	346/80e
		AD33		dyke	100/56s	000/71w
		AD34		dyke	310/70w	344/90v
		AD35		dyke	068/62nw	"
		AD36		dyke	160/88w	"
		AD37		dyke	240/80s	"
		AD38		dyke	058/86n	"
		AD39		dyke	062/68n	"
		AD40		dyke	138/88w	136/60e
		AD41		dyke	168/88w	160/90v
		AD42		dyke	301/88w	130/64e
		AD43		dyke	345/86w	343/86w
		AD44		dyke	331/90v	169/90v
		AD45		dyke	331/88w	162/90v
		AD46		dyke	165/55se	150/87w
		AD47		dyke	251/64n	152/60e
		AD48		dyke	169/80e	160/65w
		AD49		dyke	146/70e	147/77e

		AD50		dyke	305/69e	165/68e
		AD51		dyke	250/65n	354/90v
		AD52		dyke	075/53n	341/79e
	car Park	AD53	GR022209	dyke	302/81w	
	W of Dippin Head	AD54	GR040209	dyke	356/86e	010/84e
		AD55		dyke	257/50s	347/75w
		AD56		dyke	097/89s	191/75e
		AD57		dyke	354/67w	353/73w
		AD58		dyke	187/75e	001/54e
		AD59		dyke	090/77s	350/90
		AD60		dyke	139/60e	141/63e
		AD61		dyke	170/76w	182/71e
		AD62		dyke	138/58e	319/52e
		AD63		dyke	053/69s	325/70e
		AD64	GR032207	dyke	171/59e	334/67e
	Pigeon cave	AL1	947355	basalt lava	179/82e	
		AL2	"	basalt lava		
		AL3	"	basalt lava		
	String road Quarry	A9	932345	granite	232/87e	
		A10	"	granite		
		A11	"	granite		
		A12	"	granite		
	Merkland Point	AD65		dyke	034/86e	023/78e
		AD66		dyke	107/81n	216/79nw
		AD67		dyke	267/26n	032/64e
		AD68		dyke	192/42n	032/64e
		AD69		dyke	090/67n	020/64e
		AD70		dyke	067/60se	296/78ne
		AD71		dyke	272/60s	201/80w
	Cleats Shore	AD72	938217	dyke	020/90v	200/89se
		AD73		dyke	007/81w	033/86w
		AD74		dyke	273/71n	173/80w
		AD75		dyke	196/86e	214/86e
		AD76		dyke	174/65w	181/75w
		AD77		dyke	083/70n	270/90v
		AD78		dyke	188/83w	181/75w
		AD79		dyke	071/67n	277/70n
		AD80		dyke	229/73e	011/90v
		AD81		dyke	053/77nw	211/90v
		AD82		dyke	190/71w	130/87w
		AD83		dyke	136/87sw	196/79e
		AD84		dyke	309/75s	030/80w
		AD85		dyke	353/83w	179/20e
		AD86		dyke	190/69e	185/79e
		AD87		dyke	195/76w	000/90v
		AD88		dyke	175/71w	016/74w
		AD89	944212	dyke	067/77s	001/90v

Island	Location	Sample No.	Grid Ref.	Rock Type	Notes
SKYE	1km north Digg	S1	469705	tuff	Upper part of higher Red tuff layer in a landslip
		S2		tuff	Lower part of higher tuff
		S3		basalt	above upper tuff
		S4		tuff	Lower in slip
		S5		basalt	below lower tuff layer
	Dunans	S6	468707	basalt	below lower tuff
		S7		tuff	lower tuff layer
		S8		tuff/basalt	upper tuff layer
		S9		tuff	upper tuff sample 1
		S10		tuff	upper tuff sample 2
		S11		basalt	basalt above upper tuff
		S12		basalt	lower one
	1km north Uig	S13	386651	basalt	basalt above tuff
		S14		tuff	sample from LHS quarry
		S15		tuff	sample from RHS quarry
	7km South Uig	S16	403555	basalt	lava above tuff layer
		S17		tuff	well hidden tuff layer
	Preshal Beg	S18	330277	tuff	orange tuff below Preshal Beg in hill sample 1
		S19		tuff	orange tuff below Preshal Beg in hill sample 2
		S20	329280	tuff	red/orange tuff below lava above laterized flow
	Road cutting	S21	406322	tuff	tuff layer near to stream at bend in road
		S22		basalt	below tuff
		S23		basalt	above tuff
		S24	404322	tuff	nr dyke swarm
		S25		basalt	above tuff
	Road Cutting	SD1	412320	basalt	D1-D3 sampled walking west along roadside
		SD2		basalt	
		SD3	410320	basalt	
		SD4	406323	basalt	D4-D11 sampled walking westwards along roadside
		SD5		basalt	
		SD6		basalt	
		SD7		basalt	
		SD8		basalt	
		SD9		basalt	
		SD10	404322	basalt	
		SD11	404322	basalt	near tuff layer S24
	The Storr	ST1	497534	basalt	LHS gully walking up the section
		ST2		basalt	
		ST3		basalt	
		ST4		tuff	
		ST5		basalt	
		ST6		basalt	
		ST7	495535	basalt	
		ST8	497537	basalt	RHS gully
		ST9		basalt	
		St9A		basalt	
		ST10		basalt	
		ST11		basalt	between ST7 and ST8
		ST12		basalt	
		ST13		basalt	
		ST14		basalt	
		ST15		basalt	
		ST16	497538	basalt	
	Bracadale	SB1	384359	basalt	
		SB2	358382	basalt	
		SB3	358388	basalt	
		SB4	357387	basalt	
		SB5	311398	basalt	
		SB6	323388	basalt	
		SB7	329378	basalt	
		SB8	365366	basalt	
		SB9	373363	basalt	
		SB10	397340	basalt	
		SB11	413317	basalt	
		SB12	455319	basalt	

Island	Sample No.	Grid Ref.	Rock Type
Skye	SG1	492305	basalt lava
	SG2	498306	"
	SG3	498306	basalt dyke
	SG4	495305	dyke
	SG5	538300	basalt
	SG6	533282	granite
	SG7	533282	basalt dyke
	SG8	533282	"
	SG9	533282	"
	SG10	536272	granite
	SG11	549272	granite
	SG12	622258	
	SG13	622258	
	SG14	613265	basalt
	SG15	583285	
	SG16	552288	Loch Ainort G
	sg16		"
	SG17	565298	"
	SG18	565298	"
	SG19	557278	Glas Bhienn Mhor G
	SG20	614262	
	SG21	614262	OG
	SG22	614262	OG
	SG23	624263	granite
	SG24	617261	dol/gabbro
	SG24A	562307	Meall Mhaoll G
	SG25	562306	
	SG26	561310	granite
	SG27	561310	maol Glanmaich G
	SG28	496277	Glamiaig granite
	SG29		"
	SG30	495270	
	SG31	497259	Granite?
	SG32	501257	marsco granite
	SG33	501257	Marco gabbro
	SG34	503258	S Porph felsite
	SG35	500258	
	SG36	502238	granite
	SG37	503239	granite
	SG38	502242	granite

	SG39	499247	granite
	SG39B	577233	BNCG
	SG40	577233	"
	SG41	576233	"
	SG42	575233	"
	SG43	582188	Bhienn dubhaich granite
	SG44	582188	"
	SG45	504221	ILGS
	SG46	493204	gabbro
	SG47	493204	dyke
	SG48	494205	dyke
	SG49	494205	gabbro
	SG50	494205	dyke
	SG51	497208	gabbro
	SG52	498209	gabbro
	SG53	502212	gabbro
	SG54	502215	layered gabbro
	SG55	503217	gabbro
	SG56	504218	breccia
	SG57	504218	breccia
	SG58	504219	gabbro
	SG59	503223	Rudha Stac granite
	SG60	331302	Basalt lava below PM
	SG61	331300	above 60
	SG62	331301	Preshal More
	SG63	328282	lava below PB
	SG64	328280	tuff
	SG65	328279	1st flow PB
	SG66	328279	tuff
	SG67	328279	tuff
	SG68	330278	2nd flow PB
	SG69	319277	top flow PB
	SG70	332288	lava same hieght 62
	SG71	352305	eastern part Arnaval
	U031		Dagley et al, 1990
	U034		Dagley et al, 1990
	U117		Dagley et al, 1990
	U112		Dagley et al, 1990
	SK139		B Bell
	P1		palagonite tuff

Appendix C2

XRF results

All samples were analysed for Nb, Zr and Y using XRF spectrometry in Edinburgh. Particular care was taken in the determination of Nb which is believed to be precise (2σ) to ± 0.1 ppm for values < 2 ppm and ± 0.2 ppm for values > 2 ppm. Analytical methods are described in Fitton *et al.* (1998a).

Three standards were used for secondary calibration, BHVO-1, BCR-1 and BIR-1. Values for these standards can be found in the following table.

Element	Nb	Zr	Y	Sr	Rb
BHVO-1	19.8	182	27.6	403	
BCR-1		186	38	330	47.2
BIR-1	0.6	15.5	16.0	108	0.25

Skye Samples

Following samples have the SK prefix and were collected by B Bell. Nb,Y & Zr analysed in Edinburgh

Sample	Nb	Zr	Y	Ce	Ni	Cr	V	Ba	Sc	delta Nb
136	23.7	171.4	35.1	50.2	23.0	13.7	277.6	388.4	20.9	0.25
137	36.4	272.2	42.0	64.8	10.0	8.1	136.2	488.5	16.9	0.12
138	35.9	273.9	42.0	64.9	9.6	7.2	141.7	488.6	15.5	0.11
139	29.7	258.1	40.6	60.1	30.0	10.2	157.1	537.3	20.5	0.06
140	31.5	268.8	40.9	60.8	30.4	10.3	163.7	401.2	17.0	0.06
141	27.4	437.9	68.7	72.4	9.6	0.7	34.5	358.0	10.6	-0.20
142	27.5	439.0	69.0	68.1	10.8	1.9	37.4	383.2	14.2	-0.20
144	5.3	137.6	30.8	24.6	168.9	66.0	308.2	98.9	30.6	-0.27
145	2.7	96.2	18.8	23.7	617.4	771.0	290.9	45.8	26.5	-0.47
146	5.4	200.8	26.3	43.3	122.4	35.8	301.5	58.5	20.7	-0.64
147	9.3	274.8	28.8	55.1	63.2	19.6	221.5	136.3	17.1	-0.63
149	16.4	437.4	56.7	83.4	36.4	44.2	283.0	321.3	31.3	-0.50
150	4.2	139.9	19.6	33.6	10.4	2.6	57.6	223.2	9.7	-0.57
154	7.5	186.3	34.4	35.7	7.8	0.4	5.4	1241.9	10.1	-0.33
155	14.4	380.4	34.2	81.2	146.5	66.4	323.5	109.3	31.8	-0.65
156	14.9	396.6	35.0	84.3	12.4	11.8	118.7	194.3	8.5	-0.66
157	2.4	89.2	18.7	26.3	12.9	6.2	103.6	227.6	13.6	-0.46
158	17.6	492.4	61.1	90.7	279.2	645.0	338.1	61.8	30.6	-0.54
159	14.7	325.6	42.7	49.3	11.5	2.4	42.2	249.6	9.9	-0.42
160	14.6	332.7	44.7	53.1	22.9	14.6	228.0	155.8	18.3	-0.42
161	2.5	82.6	16.6	24.0	20.2	11.5	194.4	157.6	17.8	-0.43
162	14.3	294.3	40.2	47.8	294.2	651.1	309.5	80.6	32.8	-0.37
163	28.2	309.7	51.5	54.5	32.1	16.4	199.3	213.8	16.4	-0.02
164	29.7	294.1	47.7	58.4	36.3	11.3	128.6	462.9	12.6	0.02
165	0.9	42.4	20.9	9.8	28.4	8.8	122.8	368.0	15.8	-0.21
168	22.9	156.7	32.9	54.2	8.8	0.0	15.1	7076.2	16.7	0.28
169	1.7	50.2	23.4	12.4	21.0	14.9	297.2	409.9	18.5	-0.04
170	8.5	250.1	29.0	50.0	138.1	331.1	306.3	71.8	42.7	-0.59
171	5.4	144.2	24.7	44.6	29.6	19.1	270.5	109.2	16.0	-0.39
173	7.4	184.3	42.2	29.7	137.7	197.1	323.6	193.9	22.0	-0.25
174	14.6	247.0	46.1	42.3	132.7	63.8	301.9	107.8	31.6	-0.16
175	28.2	264.1	42.3	56.9	36.7	16.9	222.2	202.6	20.4	0.04
176	28.7	269.3	42.7	63.4	36.3	10.4	157.8	344.0	16.0	0.03
177	16.7	454.5	59.1	78.6	38.7	11.1	163.2	383.0	16.1	-0.51
179	30.2	259.3	41.1	61.1	9.0	5.5	59.4	208.6	11.1	0.07
180	30.2	261.8	41.3	58.7	31.4	9.0	163.4	398.3	20.0	0.06
181	29.0	287.0	48.1	55.1	30.5	10.6	159.4	387.1	16.1	0.03
182	29.6	224.3	37.6	60.1	115.9	105.5	305.2	164.9	25.7	0.15
183	36.6	287.2	44.1	71.1	28.3	9.4	136.3	347.8	18.6	0.10
184	24.1	259.2	45.6	52.4	17.6	11.7	215.7	436.0	15.9	0.01
185	4.2	140.6	23.0	33.7	11.2	7.4	115.4	479.4	14.4	-0.51
186	9.9	283.8	40.1	52.0	38.5	12.0	147.8	472.5	17.1	-0.50
187	3.5	115.8	21.9	36.1	385.7	737.1	291.5	181.2	28.3	-0.45
188	5.2	157.4	20.9	38.9	15.1	14.6	226.0	948.9	14.7	-0.55
189	2.8	112.4	27.9	25.3	130.4	312.0	301.0	241.7	28.4	-0.42
190	2.9	117.8	29.4	28.1	95.7	200.2	285.6	206.4	26.7	-0.43
192	3.1	109.3	24.5	26.2	106.5	221.0	431.8	128.0	34.9	-0.41
194	1.6	56.4	30.2	15.4	107.5	197.7	429.3	143.5	37.4	-0.06
195	4.4	158.3	22.5	34.1	135.5	283.8	339.5	225.8	30.7	-0.59
210	0.7	39.3	18.3	11.7	139.2	311.5	288.2	128.8	41.8	-0.31
212	27.2	279.8	47.9	57.0	28.5	10.1	137.9	307.5	13.1	0.02
213	13.6	239.1	45.4	48.5	32.4	19.2	209.1	260.6	17.3	-0.17
214	26.8	274.4	46.7	50.0	32.3	6.8	137.6	383.4	13.5	0.02
216	31.4	220.1	39.1	74.4	13.1	7.5	196.4	534.5	15.5	0.20

Sample	Nb	Zr	Y	Ce	Ni	Cr	V	Ba	Sc	delta Nb
217	24.8	324.6	60.3	61.7	14.8	3.3	94.8	310.3	15.6	-0.05
218	5.2	168.0	21.1	50.3	90.4	174.4	288.5	241.7	26.6	-0.60
220	25.2	324.0	59.1	64.4	14.1	6.3	91.7	310.2	14.6	-0.05
223	1.4	44.6	20.2	13.2	130.8	333.6	285.0	147.7	41.7	-0.08
224	6.9	169.4	32.2	24.9	151.9	61.9	323.2	143.6	25.9	-0.31
225	27.4	439.3	69.4	75.0	9.9	1.8	33.4	374.7	10.3	-0.20
228	25.6	370.4	63.1	66.7	14.0	4.3	73.8	341.1	13.9	-0.13
229	29.5	191.5	32.2	51.0	20.0	16.3	253.8	520.6	14.5	0.22
230	24.1	168.5	34.5	48.4	15.8	12.7	277.0	501.8	17.4	0.26
231	30.6	193.4	33.1	61.2	13.5	15.2	239.4	540.1	17.7	0.23
233	13.6	238.5	44.7	42.9	32.9	16.3	205.4	161.4	21.5	-0.17
234	3.8	118.5	20.5	30.1	276.2	550.7	354.5	92.1	33.7	-0.46
241	12.7	248.8	34.5	51.5	21.3	10.4	226.5	151.2	14.4	-0.34
243	15.7	304.7	41.3	58.4	11.3	4.7	112.7	225.0	13.1	-0.35
244	4.3	139.1	20.5	38.8	125.9	222.6	305.4	270.8	27.9	-0.54
245	2.9	103.0	18.9	35.9	152.6	438.4	297.0	317.9	34.2	-0.49
246	4.7	130.9	21.9	33.7	127.3	299.9	358.7	172.1	29.8	-0.42
247	2.2	97.4	22.1	25.6	116.5	119.2	327.4	144.6	29.0	-0.50
250	6.3	151.0	20.3	33.9	353.6	394.1	299.0	167.7	22.9	-0.44
252	2.2	97.4	19.3	30.4	73.4	48.5	291.4	244.9	25.9	-0.55
253	2.7	105.5	18.9	36.8	181.8	507.1	301.5	295.4	32.7	-0.54
254	2.7	92.6	18.2	25.9	384.1	1052.4	285.2	199.7	28.6	-0.45
255	9.0	210.2	28.3	40.0	38.7	18.5	323.1	133.6	18.6	-0.43
256	5.3	197.8	25.8	39.9	130.1	56.2	308.3	64.7	23.3	-0.64
257	15.7	315.1	48.5	70.0	13.6	4.4	126.2	291.3	13.9	-0.31
259	10.3	316.2	32.2	56.0	46.0	28.0	197.0	128.9	15.3	-0.66
260	4.6	137.1	20.2	38.6	104.2	200.0	285.6	259.6	23.2	-0.50
261	14.4	279.7	38.8	50.5	10.5	5.1	128.0	195.9	13.5	-0.34
262	5.1	195.0	26.3	40.4	140.0	70.0	316.5	85.1	25.4	-0.64
263	37.0	299.6	45.0	69.8	11.4	3.7	104.2	484.9	14.3	0.07
264	5.4	199.5	27.0	40.3	136.3	75.9	318.2	107.5	25.2	-0.63
265	2.9	94.1	19.3	19.4	366.8	708.1	290.9	162.1	27.7	-0.41
266	3.2	99.9	19.1	34.3	254.6	641.5	263.3	236.4	30.1	-0.42
267	2.7	95.9	20.0	27.2	358.1	696.6	291.2	209.8	27.2	-0.44
268	3.6	115.9	20.2	32.1	183.7	364.5	296.0	359.4	24.9	-0.47
269	4.3	131.3	20.0	41.5	110.9	215.2	283.9	273.9	26.5	-0.50
270	2.0	89.2	19.3	29.3	155.4	237.5	296.3	209.9	35.1	-0.53
271	2.2	91.5	20.0	28.4	162.1	226.6	307.7	280.4	31.6	-0.49
272	3.6	108.2	20.0	30.2	193.6	384.2	294.2	226.3	29.5	-0.42
273	6.3	132.0	18.0	41.0	329.3	539.8	294.2	458.8	21.5	-0.37
274	5.0	160.7	20.2	38.3	89.1	162.1	288.4	377.1	24.3	-0.60
275	4.8	157.8	19.8	45.3	104.9	166.0	282.2	322.2	27.0	-0.60
276	1.6	90.8	19.8	27.4	187.4	221.3	307.0	277.0	30.1	-0.62
277	3.0	119.8	22.9	31.9	82.4	64.4	310.0	331.5	26.1	-0.53
278	3.1	117.4	21.7	48.8	249.4	578.6	268.3	567.2	25.8	-0.52
279	15.4	336.7	45.3	66.2	12.6	1.9	86.8	208.9	11.2	-0.40
280	11.3	139.8	21.5	46.7	109.4	243.2	275.6	367.3	25.8	-0.10
281	3.1	101.7	18.3	31.1	217.9	558.9	285.3	270.3	30.2	-0.46
282	2.9	85.8	33.1	22.2	61.2	67.1	360.6	75.3	40.8	-0.12
284	3.2	99.4	18.7	33.2	403.6	1066.6	293.7	138.4	26.9	-0.42
285	5.2	152.5	18.0	34.1	301.5	547.8	283.0	248.8	21.1	-0.58
286	3.7	112.9	22.1	32.5	273.8	327.2	304.3	106.2	29.9	-0.40
287	2.9	87.9	16.8	25.9	369.0	777.7	260.4	199.0	25.1	-0.41
289	6.6	119.5	20.4	27.9	185.6	324.6	315.6	223.9	26.1	-0.22
290	1.7	82.3	23.4	15.5	286.4	286.2	289.2	175.1	30.2	-0.45
291	10.5	150.7	21.1	45.8	275.4	540.5	330.8	268.9	23.7	-0.20
292	7.7	121.0	17.4	35.9	403.8	867.8	288.4	202.3	22.4	-0.23

Skye Samples

Collected by LMC

Sample	Nb	Zr	Y	Ce	Ni	Cr	V	Ba	Sc	delta Nb
PT	2.7	83.8	14.3	13.8	322.3	1010.5	322.4	656.5	35.5	-0.47
S10	8.3	186.3	25.2	55.4	228.9	278.7	82.8	162.9	40.0	-0.41
S11	3.6	114.3	17.6	21.4	390.2	844.8	270.8	228.0	27.5	-0.51
S12	1.4	59.8	31.2	5.1	101.8	295.4	386.2	16.5	53.5	-0.15
S13	2.9	97.5	18.4	27.5	142.6	300.5	273.9	247.5	28.4	-0.45
S14	7.9	150.1	30.0	46.8	369.3	564.7	154.3	151.2	42.0	-0.18
S15	9.4	168.1	30.2	49.6	262.0	588.0	142.6	156.5	42.8	-0.20
S16	2.9	93.3	18.1	23.9	370.7	651.9	265.8	204.4	23.5	-0.42
S18	1.1	54.0	9.6	9.2	234.5	395.3	228.4	94.5	60.2	-0.64
S21	69.6	1728.2	37.7	198.0	36.2	293.1	423.4	720.5	28.1	-1.18
S22	1.0	52.4	23.8	5.9	135.7	324.9	321.3	15.3	53.1	-0.30
S23	4.0	138.3	22.2	29.2	168.5	359.8	356.4	516.2	37.5	-0.52
S24	118.5	746.1	33.1	76.1	44.5	445.0	445.0	379.4	8.3	-0.30
S25	3.0	93.7	19.0	24.6	112.7	258.2	312.1	262.8	34.2	-0.39
S3	2.9	95.2	19.2	16.8	448.0	679.6	264.7	84.8	25.2	-0.41
S5	4.3	129.2	21.5	33.1	91.5	79.9	312.2	332.3	24.9	-0.45
S6	4.1	130.3	19.8	34.7	82.9	82.6	288.7	408.0	27.0	-0.51
S7	4.5	150.4	26.4	33.5	623.3	1310.8	69.4	422.8	57.4	-0.47
S8	3.9	117.4	20.5	21.1	509.7	1008.5	225.3	120.0	37.5	-0.43
S9	10.2	241.0	32.0	69.9	226.1	306.5	78.9	289.4	57.7	-0.44
SB1	44.5	545.7	48.2	138.0	3.6	7.7	-14.9	1936.3	1.6	-0.32
SB10	29.7	285.4	46.8	52.6	33.0	13.6	134.5	367.0	15.1	0.04
SB11	10.0	280.1	29.5	51.7	55.1	16.8	215.3	116.7	9.2	-0.61
SB12	3.3	100.1	18.2	25.7	257.0	465.5	304.7	145.2	27.9	-0.42
SB2	44.6	555.1	51.5	142.4	2.7	8.3	-13.0	1922.2	3.5	-0.31
SB3	42.7	494.5	58.9	137.2	3.1	8.4	-12.1	1768.1	3.3	-0.17
SB4	42.0	484.8	53.1	137.8	3.3	9.8	-12.6	1746.3	0.1	-0.21
SB5	12.9	222.0	40.2	34.1	29.6	15.6	197.7	162.7	18.9	-0.18
SB6	7.0	169.0	23.2	25.4	292.7	309.4	321.3	112.5	26.6	-0.44
SB7	5.7	135.9	27.5	21.5	287.6	211.8	317.9	96.2	32.1	-0.28
SB8	47.0	563.6	35.1	110.9	1.9	7.3	-12.4	1853.0	1.4	-0.45
SB9	37.6	294.2	45.3	64.2	2.2	8.1	86.1	556.5	9.9	0.10
SD1	17.2	340.8	40.6	176.8	8.7	11.7	53.7	2037.1	11.2	-0.41
SD10	0.8	55.3	27.6	5.0	191.5	325.5	316.6	16.1	42.1	-0.38
SD11	1.6	57.3	25.8	7.4	160.8	305.2	328.0	24.9	47.0	-0.13
SD2	5.2	159.0	46.7	36.2	33.0	80.4	413.0	348.6	64.4	-0.24
SD3	17.0	340.2	40.7	173.0	4.8	12.6	56.0	2016.5	13.8	-0.41
SD4	3.8	122.4	20.6	25.8	185.9	382.0	287.0	201.1	28.3	-0.48
SD5	1.5	46.2	21.3	5.8	152.2	286.2	262.2	24.6	36.0	-0.06
SD6	1.2	57.7	28.4	6.7	106.5	211.5	377.5	12.0	47.0	-0.23
SD7	18.6	488.0	45.8	196.8	4.1	8.8	26.1	1943.7	11.1	-0.63
SD8	3.5	77.9	32.0	15.1	77.3	61.4	318.9	49.2	27.2	0.04
SD9	5.2	139.1	27.4	54.9	56.5	87.9	291.9	632.6	34.4	-0.34
SG1	1.8	73.8	17.3	18.9	179.5	133.7	227.3	162.7	18.4	-0.45
SG2	3.0	95.6	20.7	19.9	193.0	358.8	290.8	520.2	29.8	-0.38
SG24	14.0	242.5	65.4	76.2	32.5	89.3	175.0	499.7	26.9	-0.02
SG3	6.2	192.9	28.6	24.7	69.4	10.4	291.3	176.5	20.4	-0.52
SG33	11.2	494.3	34.6	95.0	8.6	14.5	68.1	1185.2	13.9	-0.97
SG4	1.6	70.5	17.6	14.0	310.1	877.5	287.2	139.2	31.0	-0.46
SG45	0.6	13.9	8.4	0.7	104.5	402.1	1570.9	45.2	68.2	0.15
SG47	0.8	24.3	10.7	8.7	54.9	340.2	90.4	120.5	40.1	-0.08
SG48	4.4	110.8	40.1	16.7	52.1	45.2	463.1	72.0	48.5	-0.06
SG49				0.8	160.0	510.0	460.1	13.3	72.6	
SG50	2.7	70.7	29.8	8.1	72.4	98.3	397.2	41.7	59.1	-0.03
SG51	0.4	15.9	12.5	1.8	133.4	273.9	202.7	23.5	87.7	0.00
SG52	2.7	68.8	27.8	9.6	74.2	109.4	402.9	45.3	57.3	-0.04
SG53	1.8	40.7	22.3	6.8	53.7	64.4	363.4	47.5	49.7	0.15
SG54	1.8	40.9	18.0	9.2	81.5	195.7	286.9	45.0	52.0	0.06
SG55	5.3	115.3	39.4	10.1	55.1	86.3	459.8	87.5	56.4	-0.03
SG57	3.4	91.8	31.3	12.6	52.1	79.9	371.5	32.0	55.0	-0.12
SG58	3.1	68.2	22.5	8.3	70.2	117.6	312.8	27.5	36.4	-0.05
SG60	24.8	261.2	43.5	45.9	37.0	14.0	134.1	326.6	11.6	0.00
SG61	32.2	313.7	46.0	58.8	13.8	11.9	93.0	437.3	11.0	-0.02
SG62A	1.6	52.6	23.3	4.5	147.0	313.6	300.9	29.2	47.9	-0.10

Sample	Nb	Zr	Y	Ce	Ni	Cr	V	Ba	Sc	delta Nb
SG62B	1.3	50.8	23.4	4.6	148.6	304.9	278.8	34.6	42.3	-0.15
SG62S	1.3	52.4	24.6	6.6	160.1	386.2	298.7	12.5	43.3	-0.17
SG62UP	1.5	53.3	24.6	8.4	138.5	311.7	298.9	29.5	48.6	-0.12
SG65	0.8	42.4	21.2	2.7	194.6	308.1	250.3	8.9	42.8	-0.27
SG68	0.6	41.7	20.5	5.8	190.6	318.9	259.3	12.3	46.0	-0.41
SG69	0.5	43.1	20.5	8.2	192.2	288.0	233.4	24.6	34.3	-0.46
SG70	24.1	152.1	34.5	40.3	12.9	12.4	270.5	532.3	15.5	0.35
SG9	3.6	62.7	29.8	21.9	89.2	85.5	295.9	109.0	42.8	0.20
SK139	30.0	264.8	41.8	50.5	23.4	14.9	144.7	416.0	11.2	0.06
SK3	4.0	120.1	19.8	28.9	128.2	267.3	298.4	143.9	25.8	-0.46
ST1	4.1	105.9	18.2	19.8	390.9	780.9	284.3	278.7	29.0	-0.37
ST10	3.5	106.5	20.9	23.8	104.9	259.3	316.7	277.8	33.9	-0.39
ST12	6.7	158.0	18.8	31.7	382.5	637.1	317.8	197.7	20.8	-0.49
ST13	3.1	96.6	17.4	20.6	408.0	976.9	282.5	96.2	27.1	-0.44
ST14	2.6	89.7	17.1	19.4	445.1	1104.7	267.9	138.3	27.3	-0.46
ST15	2.9	94.9	18.2	21.4	325.6	816.3	278.0	195.0	29.6	-0.43
ST16	3.2	97.7	18.8	22.7	310.4	773.7	282.8	203.7	32.7	-0.40
ST2	5.3	139.8	25.3	23.0	273.1	431.9	375.8	117.9	30.8	-0.37
ST3	10.6	156.8	24.0	28.1	213.1	289.5	317.3	197.3	23.6	-0.18
ST4A	10.8	158.4	23.0	33.8	291.5	384.4	216.6	131.4	31.8	-0.20
ST4B	2.9	92.3	15.8	18.8	489.7	910.0	237.8	151.7	24.0	-0.46
ST5	2.7	92.6	15.4	19.4	485.4	918.4	231.3	215.3	20.4	-0.51
ST6	3.2	92.8	17.1	19.5	408.7	787.6	250.8	134.2	24.8	-0.39
ST7	3.1	101.3	15.4	19.3	519.5	945.3	256.1	233.8	23.6	-0.52
ST8	3.4	101.1	20.1	22.7	116.7	277.6	316.8	333.8	32.1	-0.37
ST9	3.2	93.2	18.1	21.5	115.3	259.3	270.0	219.3	27.4	-0.37
U034	1.9	55.2	24.5	7.8	113.2	302.1	294.6	25.4	46.2	-0.04

Mull Samples

Samples collected by Kerr (1993) and analysed for Nb, Zr and & Y in Edinburgh.

Sample	Nb*	Zr*	Y*	Zr/Y	Nb/Y	delta Nb
BM1	2.03	56.17	18.22	3.08	0.11	-0.15
BM2	5.53	125.57	23.44	5.36	0.24	-0.29
BM3	4.78	117.11	19.59	5.98	0.24	-0.36
BM4	2.23	80.92	19.20	4.21	0.12	-0.39
BM5	4.03	97.03	17.66	5.49	0.23	-0.32
BM6	7.53	154.10	20.87	7.38	0.36	-0.37
BM7	2.23	105.05	21.50	4.89	0.10	-0.57
BM8	2.44	82.45	20.51	4.02	0.12	-0.35
BM9	1.63	82.96	18.44	4.50	0.09	-0.57
BM10	1.83	60.67	13.84	4.38	0.13	-0.37
BM11	2.74	95.95	24.12	3.98	0.11	-0.36
BM12	3.25	74.99	18.98	3.95	0.17	-0.17
BM13	2.54	88.28	19.86	4.45	0.13	-0.40
BM14	2.54	90.33	19.86	4.55	0.13	-0.42
BM15	2.23	89.30	19.31	4.62	0.12	-0.47
BM16	3.85	106.08	19.42	5.46	0.20	-0.38
BM17	4.78	104.43	18.30	5.71	0.26	-0.30
BM18	3.65	88.58	20.87	4.24	0.18	-0.22
BM19	2.54	83.07	19.75	4.21	0.13	-0.35
BM20	2.84	102.60	23.80	4.31	0.12	-0.40
BM21	5.55	102.99	22.69	4.54	0.24	-0.13
BM22	3.92	103.26	23.64	4.37	0.17	-0.27
BM23	2.84	91.25	18.87	4.83	0.15	-0.40
BM24	4.45	87.47	18.67	4.68	0.24	-0.17
BM25	5.19	82.64	18.82	4.39	0.28	-0.05
BM26	2.44	82.96	20.84	3.98	0.12	-0.34
BM27	4.00	78.74	19.96	3.94	0.20	-0.10
BM28	4.84	83.18	17.84	4.66	0.27	-0.11
BM30	4.54	101.71	17.78	5.72	0.26	-0.31
BM31	2.64	91.66	18.87	4.86	0.14	-0.43
BM32	3.80	87.56	18.44	4.75	0.21	-0.24
BM33	3.82	75.04	16.29	4.61	0.23	-0.16
BM34	8.90	154.44	19.23	8.03	0.46	-0.33
BM35	5.22	100.17	22.31	4.49	0.23	-0.14
BM36	7.59	122.22	18.06	6.77	0.42	-0.23
BM37	4.53	98.59	23.68	4.16	0.19	-0.17
BM38	15.63	237.68	31.12	7.64	0.50	-0.25
BM39	4.59	98.13	19.97	4.91	0.23	-0.23
BM40	4.45	81.70	19.73	4.14	0.23	-0.09
BM41	3.82	88.13	20.09	4.39	0.19	-0.21
BM42	4.07	88.02	19.80	4.44	0.21	-0.19
BM44	6.43	121.08	20.46	5.92	0.31	-0.25
BM45	7.06	115.72	21.37	5.41	0.33	-0.15

Sample	Nb*	Zr*	Y*	Zr/Y	Nb/Y	delta Nb
BM46	5.15	84.36	19.98	4.22	0.26	-0.05
BM47	6.33	89.62	19.73	4.54	0.32	-0.02
BM48	6.18	88.12	20.34	4.33	0.30	0.00
BM49	7.03	112.63	24.45	4.61	0.29	-0.08
BM50	5.83	115.57	23.03	5.02	0.25	-0.20
BM51	5.88	118.86	21.27	5.59	0.28	-0.25
BM52	15.19	212.79	29.05	7.32	0.52	-0.20
BM53	11.14	208.29	26.97	7.72	0.41	-0.35
BM54	11.12	206.72	29.68	6.96	0.37	-0.30
BM55	10.91	177.77	26.73	6.65	0.41	-0.23
BM56	10.42	184.65	29.03	6.36	0.36	-0.25
BM57	9.08	178.37	27.20	6.56	0.33	-0.30
BM58	10.30	184.16	30.05	6.13	0.34	-0.24
BM60	61.87	979.63	71.66	13.67	0.86	-0.50
BM61	58.77	924.47	65.99	14.01	0.89	-0.51
BM62	59.58	938.97	66.32	14.16	0.90	-0.52
BM63	58.48	945.72	65.82	14.37	0.89	-0.53
BM64	27.66	381.10	55.86	6.82	0.50	-0.17
BM65	29.92	389.26	57.59	6.76	0.52	-0.14
BM66	24.71	361.46	53.38	6.77	0.46	-0.19
BM67	18.00	265.42	39.44	6.73	0.46	-0.19
BM68	9.56	112.18	22.40	5.01	0.43	0.03
BM70	11.15	111.21	22.12	5.03	0.50	0.10
BM71	8.95	115.82	22.22	5.21	0.40	-0.03
MR1	7.15	184.75	27.68	6.68	0.26	-0.43
MR2	3.65	74.84	17.40	4.30	0.21	-0.15
MR3	3.04	94.21	21.61	4.36	0.14	-0.34
MR4	4.03	116.06	21.26	5.46	0.19	-0.40
MR5	2.84	104.44	21.94	4.76	0.13	-0.45
MR6	3.78	148.82	28.19	5.28	0.13	-0.52
MR7	3.53	91.75	18.56	4.94	0.19	-0.31
MR8	3.78	93.86	21.00	4.47	0.18	-0.25
MR9	3.35	99.33	26.09	3.81	0.13	-0.27
MR10	3.90	95.98	18.30	5.24	0.21	-0.31
MR11	2.64	79.28	19.42	4.08	0.14	-0.30
MR12	3.65	84.35	17.27	4.88	0.21	-0.26
MR13	3.90	91.75	16.89	5.43	0.23	-0.31
MR14	4.95	75.75	16.72	4.53	0.30	-0.05
MR15	7.09	206.29	31.92	6.46	0.22	-0.47
MR16	8.69	209.96	31.94	6.57	0.27	-0.40
MR17	7.96	152.18	28.56	5.33	0.28	-0.21
MR18	7.60	145.11	25.82	5.62	0.29	-0.23
MR19	5.50	183.99	30.79	5.98	0.18	-0.50
MR20	2.54	74.27	18.87	3.94	0.13	-0.27
MR21	16.39	272.50	33.56	8.12	0.49	-0.32
MR22	15.91	273.43	31.33	8.73	0.51	-0.36
MR23	14.45	276.99	37.16	7.45	0.39	-0.35
MR24	15.51	257.06	35.73	7.19	0.43	-0.27

Sample	Nb*	Zr*	Y*	Zr/Y	Nb/Y	delta Nb
MR25	16.37	298.91	39.47	7.57	0.41	-0.33
MR26	12.27	223.26	34.55	6.46	0.36	-0.27
MR27	13.22	250.62	34.03	7.36	0.39	-0.34
MR28	25.76	347.17	54.20	6.41	0.48	-0.13
MR29	25.75	356.55	54.96	6.49	0.47	-0.15
MR30	7.76	107.18	21.85	4.91	0.36	-0.04
MR31	5.27	92.95	21.62	4.30	0.24	-0.09
MR32	4.10	76.91	18.69	4.12	0.22	-0.10
MR33	9.70	293.69	37.40	7.85	0.26	-0.56
MR34	8.03	210.72	31.80	6.63	0.25	-0.43
MR35	6.18	157.10	27.29	5.76	0.23	-0.36
MR36	11.49	191.01	31.83	6.00	0.36	-0.20
MR37	12.60	196.76	32.11	6.13	0.39	-0.18
MR38	13.30	210.60	33.71	6.25	0.39	-0.19
MR39	11.85	208.03	40.25	5.17	0.29	-0.16
MR40	7.41	118.78	24.16	4.92	0.31	-0.10
MR41	5.30	119.67	19.38	6.17	0.27	-0.34
BG1	7.28	120.90	27.64	4.37	0.26	-0.07
BG2	4.79	101.60	24.47	4.15	0.20	-0.16
BG3	5.53	102.46	18.74	5.47	0.30	-0.21
BG4	4.95	112.93	18.65	6.06	0.27	-0.34
BG5	4.19	106.47	20.27	5.25	0.21	-0.33
BG6	2.84	120.09	20.62	5.82	0.14	-0.59
BG7	3.77	129.05	26.95	4.79	0.14	-0.42
BG8	5.33	133.93	27.40	4.89	0.19	-0.29
BR1	7.51	169.90	28.58	5.94	0.26	-0.33
BR2	7.71	171.60	27.94	6.14	0.28	-0.33
BR3	7.31	166.70	27.08	6.16	0.27	-0.34
BR4	2.24	73.40	20.72	3.54	0.11	-0.28
BR5	2.55	97.50	21.05	4.63	0.12	-0.46
BR6	2.24	77.90	17.60	4.43	0.13	-0.39
BR7	2.75	87.50	20.83	4.20	0.13	-0.34
BR8	2.75	86.70	19.76	4.39	0.14	-0.35
BR9	2.95	96.10	22.45	4.28	0.13	-0.35
BR10	2.75	92.80	22.23	4.17	0.12	-0.36
BR11	2.75	78.60	18.14	4.33	0.15	-0.30
BR12	1.76	80.43	18.79	4.28	0.09	-0.50
BR13	2.14	92.80	22.77	4.08	0.09	-0.46
BR14	2.75	100.70	19.65	5.13	0.14	-0.48
BR15	3.97	104.90	22.77	4.61	0.17	-0.29
BR16	3.66	101.00	21.80	4.63	0.17	-0.31
BR17	3.97	106.50	26.11	4.08	0.15	-0.25
BR18	19.25	281.30	18.25	15.41	1.06	-0.52
BR19	17.33	266.20	19.22	13.85	0.90	-0.50
BR20	7.91	157.20	25.46	6.17	0.31	-0.29
BR21	4.88	125.30	26.75	4.68	0.18	-0.29
BR22	3.36	140.20	29.87	4.69	0.11	-0.50
BR23	8.72	188.30	32.03	5.88	0.27	-0.30

Sample	Nb*	Zr*	Y*	Zr/Y	Nb/Y	delta Nb
BR24	9.74	200.40	32.13	6.24	0.30	-0.30
BR25	5.99	249.90	31.16	8.02	0.19	-0.71
BR26	11.05	215.50	33.86	6.37	0.33	-0.29
BR27	7.41	239.70	30.73	7.80	0.24	-0.59
BR28	14.50	274.00	38.59	7.10	0.38	-0.32
BR29	12.47	238.30	35.15	6.78	0.35	-0.31
BR30	12.17	232.00	36.65	6.33	0.33	-0.28
BR31	11.86	226.40	35.47	6.38	0.33	-0.28
BR32	12.57	244.80	37.52	6.53	0.34	-0.30
BR33	13.08	239.80	37.08	6.47	0.35	-0.27
BCH2	4.15	102.32	27.29	3.75	0.15	-0.18
BCH3	3.45	96.77	23.58	4.10	0.15	-0.27
BCH4	3.55	103.52	26.86	3.85	0.13	-0.26
BCH5	11.02	184.75	24.72	7.47	0.45	-0.29
BCH6	11.02	188.82	26.77	7.05	0.41	-0.27
BCH2X	4.78	168.15	43.35	3.88	0.11	-0.35
BCH3X	3.65	104.95	28.50	3.68	0.13	-0.24
BCH4X	3.65	108.84	28.83	3.78	0.13	-0.27
BCH8	3.78	107.92	25.88	4.17	0.15	-0.29
BCH9	3.65	109.61	23.31	4.70	0.16	-0.36
BCH10A	1.63	74.27	17.56	4.23	0.09	-0.50
BCH10B	7.65	243.84	31.15	7.83	0.25	-0.59
BCH11	6.90	214.98	32.94	6.53	0.21	-0.50
BCH12	5.15	178.73	33.97	5.26	0.15	-0.46
BCH13	3.65	130.54	30.37	4.30	0.12	-0.40
BCH14	3.45	103.01	22.70	4.54	0.15	-0.34
BCH15	2.23	128.37	24.45	5.25	0.09	-0.68
BCH16	2.94	124.18	22.81	5.44	0.13	-0.56
BCH17	2.54	110.27	16.14	6.83	0.16	-0.67
BCH18	13.77	240.88	27.81	8.66	0.50	-0.37
BCH19	6.53	165.20	31.40	5.26	0.21	-0.33
BCH20	4.03	114.58	29.35	3.90	0.14	-0.26
BCH21	3.78	84.77	22.67	3.74	0.17	-0.14
BCH22	2.54	78.77	19.20	4.10	0.13	-0.32
BCH23A	3.65	90.59	20.74	4.37	0.18	-0.24
BCH23B	2.23	74.48	15.81	4.71	0.14	-0.40
BCH24	1.93	81.02	17.78	4.56	0.11	-0.49
BCH25	1.93	81.94	18.22	4.50	0.11	-0.49
BCH26	2.23	83.58	18.55	4.51	0.12	-0.43
BCH27	2.13	82.86	18.22	4.55	0.12	-0.45
BCH28	2.44	59.13	16.14	3.66	0.15	-0.16
BCH29	2.03	81.33	18.55	4.39	0.11	-0.45
BCH30	2.13	82.86	18.44	4.49	0.12	-0.45
BCH31	2.54	86.44	20.30	4.26	0.13	-0.37
BCH32	3.35	103.42	20.41	5.07	0.16	-0.40
BCH33	3.75	92.68	20.51	4.52	0.18	-0.26
BCH34A	3.78	82.76	18.94	4.37	0.20	-0.19
BCH34B	4.90	93.97	26.65	3.53	0.18	-0.05

Sample	Nb*	Zr*	Y*	Zr/Y	Nb/Y	delta Nb
BCH34C	5.40	108.66	29.09	3.74	0.19	-0.09
BCH35	4.40	88.89	22.80	3.90	0.19	-0.11
BCH36	4.03	91.64	21.64	4.23	0.19	-0.19
BCH37	3.78	80.54	22.28	3.61	0.17	-0.10
BCH38	4.90	96.40	25.49	3.78	0.19	-0.08
BCH41	4.53	108.87	24.34	4.47	0.19	-0.24
BCH42	5.53	113.10	24.08	4.70	0.23	-0.19
BCH43	7.15	159.60	29.09	5.49	0.25	-0.29
BCH44	10.40	182.22	34.36	5.30	0.30	-0.17
BCH45	7.65	163.83	29.60	5.53	0.26	-0.27
BCH46	11.02	193.32	33.59	5.76	0.33	-0.20
B3	7.28	153.49	38.65	3.97	0.19	-0.14
B4A	16.02	402.48	14.98	26.87	1.07	-0.98
B4B	6.03	153.26	38.74	3.96	0.16	-0.21
B5	16.02	387.68	15.73	24.64	1.02	-0.92
B6	2.44	104.13	21.06	4.94	0.12	-0.53
B7	4.78	222.80	30.35	7.34	0.16	-0.73
B8	5.65	229.14	30.97	7.40	0.18	-0.67
B9	4.78	129.56	27.77	4.67	0.17	-0.31
B10	2.44	129.91	26.42	4.92	0.09	-0.62
B11	4.15	69.62	19.59	3.55	0.21	0.01
B12	2.54	74.07	19.42	3.81	0.13	-0.26
B13	4.78	119.01	19.02	6.26	0.25	-0.39
B14	5.40	150.45	28.14	5.35	0.19	-0.37
B15	11.02	205.09	29.01	7.07	0.38	-0.31
B16A	3.14	108.02	24.34	4.44	0.13	-0.39
B16B	2.84	102.80	22.59	4.55	0.13	-0.42
B17	2.64	105.67	23.47	4.50	0.11	-0.46
B18	1.83	81.74	19.75	4.14	0.09	-0.48
B19	2.44	131.44	28.17	4.67	0.09	-0.61
B20	2.34	91.45	18.87	4.85	0.12	-0.48
B21	2.34	91.86	19.97	4.60	0.12	-0.46
B22	2.94	92.88	19.97	4.65	0.15	-0.37
B23	2.64	90.22	19.75	4.57	0.13	-0.40
B24	2.64	95.44	19.75	4.83	0.13	-0.45
B25A	1.93	78.26	17.78	4.40	0.11	-0.46
B25B	4.78	90.50	20.87	4.34	0.23	-0.12
B26	2.64	88.59	20.62	4.30	0.13	-0.37
B27	2.34	78.46	20.19	3.89	0.12	-0.33
B28	2.13	82.76	19.64	4.21	0.11	-0.42
B29	2.13	80.00	17.78	4.50	0.12	-0.43
B30	2.94	98.30	23.36	4.21	0.13	-0.36
W6	4.78	110.68	26.56	4.17	0.18	-0.19
W7	4.78	134.94	36.19	3.73	0.13	-0.24
BB1	2.64	110.88	25.44	4.36	0.10	-0.47
BB2	3.78	119.65	23.70	5.05	0.16	-0.41
BB3	3.65	110.35	24.34	4.53	0.15	-0.34
*BB4	19.14	267.62	18.05	14.83	1.06	-0.48

Sample	Nb*	Zr*	Y*	Zr/Y	Nb/Y	delta Nb
BB5	12.02	200.29	23.95	8.36	0.50	-0.33
BB6	6.15	126.20	30.89	4.09	0.20	-0.13
BB7A	4.28	153.26	34.48	4.44	0.12	-0.41
BB7B	4.90	121.34	27.29	4.45	0.18	-0.25
BB8	4.78	156.54	34.87	4.49	0.14	-0.38
BB9	2.64	109.04	25.44	4.29	0.10	-0.46
BB10A	6.65	192.89	40.52	4.76	0.16	-0.35
BB10B	10.65	182.64	35.77	5.11	0.30	-0.15
BB11	11.52	188.88	37.70	5.01	0.31	-0.12
BB12	14.27	219.10	41.29	5.31	0.35	-0.11
BB13	15.39	230.20	41.16	5.59	0.37	-0.12
BB14	12.90	212.23	42.70	4.97	0.30	-0.12
BB15	14.77	209.49	40.91	5.12	0.36	-0.06
BB16	13.52	199.66	41.93	4.76	0.32	-0.05
BB17	13.15	216.46	45.27	4.78	0.29	-0.10
BB18	8.28	158.12	37.31	4.24	0.22	-0.12
BB19	11.52	147.87	35.64	4.15	0.32	0.06
BB20	3.78	131.91	21.00	6.28	0.18	-0.54
BB21	4.56	131.24	19.75	6.65	0.23	-0.48
BB22	4.03	107.07	18.43	5.81	0.22	-0.39
BB23	5.65	120.07	23.18	5.18	0.24	-0.24
BB24	4.03	134.87	28.83	4.68	0.14	-0.40
BHL2	9.27	155.90	41.42	3.76	0.22	-0.02
BHL3	7.65	153.68	38.21	4.02	0.20	-0.12
BHL5	7.03	149.03	36.67	4.06	0.19	-0.15
BHL6	9.27	164.25	45.14	3.64	0.21	-0.02
*BHL7	8.53	150.41	40.26	3.74	0.21	-0.03
BHL8	6.53	143.85	34.87	4.13	0.19	-0.17
*BHL9	8.03	156.22	39.36	3.97	0.20	-0.10
BHL10	9.77	190.36	51.57	3.69	0.19	-0.07
BHL11	6.03	88.58	29.86	2.97	0.20	0.14
BHL12 sill?	4.78	87.52	27.29	3.21	0.18	0.01
BHL13	5.40	88.68	31.15	2.85	0.17	0.11
BHL14A	2.23	113.75	23.80	4.78	0.09	-0.59
BHL14B	5.40	115.84	24.85	4.66	0.22	-0.21
BHL15	1.63	72.02	18.87	3.82	0.09	-0.44
BHL16	4.36	136.04	20.84	6.53	0.21	-0.50
BHL17	4.03	127.15	23.18	5.48	0.17	-0.44
BHL18	3.65	122.19	22.80	5.36	0.16	-0.45
BHL19	2.54	64.86	18.11	3.58	0.14	-0.18
BHL20	1.63	81.02	17.23	4.70	0.09	-0.58
BHL23	3.90	128.00	30.37	4.21	0.13	-0.35
BHL24	2.54	92.47	22.70	4.07	0.11	-0.38
BHL25	2.74	95.03	20.95	4.54	0.13	-0.40
BHL26	2.44	88.69	19.42	4.57	0.13	-0.43
BHL27	2.44	85.52	19.75	4.33	0.12	-0.39
BHL28	3.25	81.43	20.73	3.93	0.16	-0.21
BHL29	2.54	91.15	19.42	4.69	0.13	-0.43

Sample	Nb*	Zr*	Y*	Zr/Y	Nb/Y	delta Nb
BHL30	2.64	90.43	20.84	4.34	0.13	-0.38
BHL31	2.74	91.86	20.51	4.48	0.13	-0.38
BHL32	2.44	85.93	18.44	4.66	0.13	-0.42
BHL33	1.83	80.61	19.53	4.13	0.09	-0.47
BHL34	2.03	78.77	20.30	3.88	0.10	-0.39
BHL35	2.44	84.29	21.50	3.92	0.11	-0.34
BHL36	2.74	99.43	23.03	4.32	0.12	-0.40
AM1	7.53	142.48	40.39	3.53	0.19	-0.04
AM2A	7.28	141.00	38.21	3.69	0.19	-0.07
AM2B	7.90	143.11	40.01	3.58	0.20	-0.03
AM2C	8.03	143.11	39.62	3.61	0.20	-0.02
AM3	8.03	152.94	38.85	3.94	0.21	-0.09
AM4	8.28	151.36	38.59	3.92	0.21	-0.07
AM5	6.53	142.37	38.85	3.66	0.17	-0.12
AM6	2.64	130.72	25.66	5.10	0.10	-0.61
AM7A	4.40	112.89	24.98	4.52	0.18	-0.27
AM7B	4.66	119.58	21.17	5.65	0.22	-0.36
AM8	4.03	122.40	32.17	3.80	0.13	-0.28
AM9	4.03	118.59	24.21	4.90	0.17	-0.36
AM10	5.15	132.02	27.42	4.81	0.19	-0.30
AM15	2.34	82.76	19.75	4.19	0.12	-0.38
CA2	2.91	65.75	27.68	2.38	0.10	0.04
CA3A	15.39	175.56	37.18	4.72	0.41	0.06
CA4	24.39	222.49	55.68	4.00	0.44	0.23
CA5	23.01	280.72	55.93	5.02	0.41	0.01
CA6	30.63	388.00	66.72	5.82	0.46	-0.07
CA7	35.63	541.04	65.69	8.24	0.54	-0.28
CA8	39.00	580.78	67.75	8.57	0.58	-0.29
CA9	16.27	286.01	73.14	3.91	0.22	-0.05
CA10	9.90	114.58	26.14	4.38	0.38	0.09
CA11	25.39	253.03	46.04	5.50	0.55	0.06
CA18	22.76	249.33	46.17	5.40	0.49	0.03
K1	3.90	138.78	34.87	3.98	0.11	-0.36
*K3	11.40	111.93	38.72	2.89	0.29	0.32
*K4	49.86	1146.01	89.45	12.81	0.56	-0.64
C1	8.65	184.12	35.64	5.17	0.24	-0.24
C2	6.90	176.72	30.76	5.75	0.22	-0.37
C3	8.65	176.09	32.17	5.47	0.27	-0.25
C4	15.27	171.12	28.96	5.91	0.53	-0.02
C5	8.78	193.95	36.15	5.36	0.24	-0.28
T2	5.03	101.47	29.35	3.46	0.17	-0.06
T3	6.53	113.31	36.28	3.12	0.18	0.05
T4	5.53	102.42	30.50	3.36	0.18	-0.01
T5	6.03	105.38	28.45	3.70	0.21	-0.03
T6	4.90	108.02	28.71	3.76	0.17	-0.13
T7	4.53	109.82	28.83	3.81	0.16	-0.18
T8	6.15	135.08	27.93	4.84	0.22	-0.23
T9	3.25	93.09	21.17	4.40	0.15	-0.31

Sample	Nb*	Zr*	Y*	Zr/Y	Nb/Y	delta Nb
T10	6.78	113.52	33.20	3.42	0.20	0.02
T11	4.90	121.97	38.85	3.14	0.13	-0.11
T12	3.35	89.20	18.44	4.84	0.18	-0.32
T15	4.53	125.78	26.91	4.67	0.17	-0.32
T16	4.28	92.28	19.46	4.74	0.22	-0.22
A5	2.23	81.74	20.95	3.90	0.11	-0.37
A6	1.93	74.07	18.33	4.04	0.11	-0.40
STA3		59.72	18.43	3.24		
UV2a	19.06	406.70	13.59	29.92	1.40	-0.95
UV3	18.52	370.77	11.88	31.21	1.56	-0.94
UV4	0.66	102.32	20.74	4.93	0.03	-1.09
UV5	16.02	359.46	15.86	22.66	1.01	-0.86
UV6	2.54	133.89	26.75	5.01	0.09	-0.63
UV7	3.65	124.19	22.67	5.48	0.16	-0.47
UV9	3.25	127.14	27.30	4.66	0.12	-0.47
UV10	3.45	133.48	29.05	4.60	0.12	-0.46
UV11	6.07	114.26	24.02	4.76	0.25	-0.16
EX1	4.03	102.32	14.32	7.14	0.28	-0.45
EX2	3.28	103.37	14.83	6.97	0.22	-0.53
EX2A	2.28	104.43	18.56	5.63	0.12	-0.61
EX2B	2.41	102.32	15.73	6.50	0.15	-0.64
EX3	2.41	105.49	18.30	5.76	0.13	-0.60
EX9N+	5.53	90.69	34.87	2.60	0.16	0.14
EX10N+	11.40	139.73	32.43	4.31	0.35	0.07
EX19	2.41	100.73	21.64	4.65	0.11	-0.50
EX20	2.78	95.76	22.16	4.32	0.13	-0.38
BM10A	4.99	87.28	22.76	3.83	0.22	-0.04
BM10B	5.83	92.87	23.03	4.03	0.25	-0.02
BM10C	5.48	112.51	29.85	3.77	0.18	-0.10
P12	5.55	76.76	18.69	4.11	0.30	0.03
P35	6.00	94.52	19.45	4.86	0.31	-0.09
MS195		75.89	19.59	3.87		
) May be sills						
AM11	2.41	88.37	22.67	3.90	0.11	-0.37
AM12	2.28	86.46	23.44	3.69	0.10	-0.36
AM13	2.03	87.41	21.26	4.11	0.10	-0.46
*AM14	2.41	87.10	21.26	4.10	0.11	-0.38
BHL21	1.91	84.24	22.67	3.72	0.08	-0.43
BHL22	2.03	88.89	22.16	4.01	0.09	-0.46
BCH39	4.03	82.24	20.61	3.99	0.20	-0.12
BCH40	7.03	87.31	24.21	3.61	0.29	0.13
BM29A	3.65	74.47	19.25	3.87	0.19	-0.11
BM29B	3.64	64.76	18.67	3.47	0.20	-0.01

Mull Samples

Collected by LMC

Sample	Nb*	Zr*	Y*	Zr/Y	Delta Nb	La	Ce	Nd	Ce/Y	Zn	Cu	Ni	Cr	V	Ba	Sc
SO17	0.94	37.30	12.57	2.97	-0.29					36.59	228.68	59.45	193.54	147.49	50.17	23.57
SO31	3.36	77.87	24.93	3.12	-0.08					73.61	23.33	71.98	226.93	474.69	123.80	41.69
SO33	5.18	127.47	42.77	2.98	-0.09					81.70	72.82	64.76	183.28	274.56	186.56	47.59
SO34	2.05	57.95	24.58	2.36	-0.05					90.51	182.63	101.28	291.80	300.16	37.44	50.87
SO38	3.67	90.81	27.67	3.28	-0.13					86.99	116.72	56.80	178.15	264.17	116.81	35.35
dykes cutting Loch Ba																
D1	3.47	94.61	23.78	3.98	-0.25	0.87	16.89	9.94	0.71	92.80	93.43	127.61	103.22	279.27	114.87	23.11
E001	6.09	104.98	32.82	3.20	0.04					104.10	73.25	81.32	96.98	309.48	190.64	39.54
E003	2.86	72.73	28.81	2.52	-0.04					94.35	138.19	125.06	139.33	358.98	55.71	47.81
E007	28.82	462.04	140.43	3.29	0.06					184.36	32.78	8.81	10.79	48.60	553.47	31.39
E008	3.67	97.07	27.56	3.52	-0.19					96.11	87.20	87.48	131.98	320.31	138.57	39.66
E002	5.26	91.74	28.76	3.19	0.03	9.52	20.66	15.09	0.72	106.07	82.37	84.93	110.06	331.66	221.72	40.68
E005	3.73	92.96	27.71	3.35	-0.14	4.74	15.40	11.13	0.56	96.01	94.93	95.86	132.59	306.48	94.85	37.96
E006	8.10	130.95	37.91	3.45	0.04	7.39	20.56	16.29	0.54	117.27	83.55	74.10	133.19	429.91	158.00	36.37
E010	10.44	134.71	32.96	4.09	0.07	4.54	26.51	19.06	0.80	97.25	95.57	93.63	126.05	315.81	145.08	32.18
COLSTAFFA1	3.39	105.77	29.37	3.60	-0.27	7.59	20.06	14.54	0.68	85.85	55.21	61.36	195.85	326.52	184.71	44.87
COLSTAFFA2	3.49	105.97	30.57	3.47	-0.24	5.76	20.96	14.27	0.69	87.20	54.78	60.09	195.05	330.48	185.00	42.94
STAFFAPILLOW	3.07	104.66	29.37	3.56	-0.30	8.00	21.65	15.74	0.74	86.68	54.14	64.33	200.98	324.48	172.76	45.66
DYKELBA	4.22	89.49	26.88	3.33	-0.07	6.37	15.00	9.75	0.56	92.17	76.25	75.48	93.77	299.84	189.67	35.69
LAVALBA	8.61	191.22	53.81	3.55	-0.11	19.91	44.08	26.33	0.82	114.47	61.33	19.11	23.56	291.81	345.39	40.45
PLATLBA	14.87	442.31	21.89	20.21	-0.93	28.25	86.85	29.92	3.97	59.61	19.04	19.32	160.65	131.74	112.53	18.02
G1	14.80	277.40	38.22	7.26	-0.32	32.53	73.16	34.71	1.91	98.71	21.08	19.21	49.91	186.49	691.61	24.47
GD1	11.96	221.79	45.79	4.84	-0.16	28.97	60.65	31.76	1.32	141.22	11.52	11.99	24.57	381.59	621.86	44.87
GD2	4.75	106.50	31.70	3.36	-0.09	15.22	33.26	17.31	1.05	98.29	76.89	62.95	236.28	370.45	334.02	67.07
GPNT1	3.12	69.64	35.38	1.97	0.12	4.84	11.33	8.28	0.32	93.52	134.00	78.45	273.90	373.98	65.61	50.64
GPNT2	20.19	346.35	47.79	7.25	-0.29	39.45	90.13	44.66	1.89	98.19	134.32	75.48	267.06	374.84	58.72	50.31
GPNTD1	2.82	69.23	36.01	1.92	0.09	2.09	14.80	11.23	0.41	71.43	50.81	87.16	169.10	143.96	74.84	17.79
LBA1	7.39	115.67	32.65	3.54	0.04	12.58	29.69	16.11	0.91	88.23	56.71	58.60	186.70	371.73	199.77	56.76
M13	5.49	107.24	36.25	2.96	0.02	6.17	15.30	11.50		97.98	92.14	87.80	136.51	381.37	111.95	31.27
MQ	0.08	12.30	4.37	2.81	-0.87	-1.98	2.40	2.20	0.55	130.75	3.69	319.66	425.67	76.46	97.96	12.81
BO	13.99	417.64	48.00	8.70	-0.60	46.07	99.85	44.20	2.08	52.15	8.73	3.18	11.29	17.96	834.02	7.82
BBG	0.20	11.18	3.84	2.91	-0.43	0.67	3.09	3.77	0.81	51.21	75.07	314.99	439.65	66.39	15.29	9.75
BBG1	3.12	78.70	23.29	3.38	-0.15	7.79	16.59	9.38	0.71	89.17	194.44	117.73	224.72	266.09	158.00	41.47
BBQ1	3.53	78.90	27.71	2.85	-0.03	1.69	14.71	10.95	0.53	79.42	224.60	77.29	255.29	298.56	116.61	50.19
BC	5.66	111.29	30.76	3.62	-0.07	9.52	31.77	16.29	1.03	93.42	78.61	34.71	162.76	304.23	173.93	45.21
C1	6.48	125.55	31.60	3.97	-0.10	15.94	36.04	17.77	0.77	94.66	52.21	17.94	40.76	318.91	173.05	56.76
C2	6.17	119.34	29.81	4.00	-0.10	16.04	32.97	16.20	0.82	90.62	55.43	18.90	39.65	304.13	156.05	54.84
C3	11.35	195.31	46.53	4.20	-0.07	26.02	57.68	29.00		117.79	13.24	3.61	8.68	308.84	245.52	57.78
CD1	2.31	69.64	40.01	1.74	0.04	0.57	8.95	9.02	0.08	104.62	252.40	71.76	85.72	427.87	17.04	57.33

Antrim samples
Collected by LMC

Sample	Nb	Zr	Y	Sr	Rb	La	Ce	Nd	Zn	Cu	Ni	Cr	V	Ba	Sc	Location
DYKEBMQ	2.45	126.10	28.57	268.84	2.80	4.33	19.87	15.56	98.40	69.06	67.09	36.23	268.34	97.48	27.31	Black Mtn Qry
I1	24.58	245.42	60.40	147.79	104.33	33.34	74.15	35.63	122.24	30.52	14.44	19.44	177.70	426.70	32.52	Carlingford
I2	10.90	95.46	42.44	141.40	30.50	12.48	30.29	16.48	120.27	101.91	30.79	28.99	343.98	225.61	58.12	Carlingford
I3	12.15	135.10	29.77	319.99	22.34	16.24	31.38	18.32	45.72	27.20	57.65	233.77	279.06	376.86	37.73	Carlingford
I4	15.60	203.96	51.82	209.45	69.38	28.97	59.86	26.88	129.92	20.97	6.90	8.07	292.02	415.14	37.84	Carlingford
LBBMQ	2.55	92.32	26.58	168.31	11.56	3.93	16.00	14.36	84.71	113.93	386.97	988.31	275.20	106.22	38.30	Black Mtn Qry
LBIBQ	2.24	85.65	23.99	212.13	6.62	4.54	11.73	11.87	77.14	131.32	456.29	1272.54	261.70	76.01	37.16	Keely Mtn Qry
MAC110120	5.89	112.24	31.47	285.65	6.82	11.46	27.51	18.41	92.59	83.34	108.92	25.98	203.20	365.21	26.40	Ballymacilroy Bhole.
MAC11401150	13.09	241.48	21.89	138.10	2.49	7.39	18.77	14.54	91.55	129.81	323.59	504.93	402.70	113.31	55.74	Ballymacilroy Bhole.
MAC13601370	2.34	113.96	25.28	185.94	1.08	1.28	18.18	14.17	87.30	96.75	210.52	514.68	290.20	68.92	37.28	Ballymacilroy Bhole.
MAC14401450	1.19	87.87	23.39	248.94	0.68	1.38	7.26	9.02	77.35	96.86	187.70	327.31	264.06	28.31	34.78	Ballymacilroy Bhole.
MAC16201630	2.66	131.96	31.27	267.91	2.19	4.33	15.00	15.65	93.42	67.77	135.57	143.65	254.95	77.85	28.55	Ballymacilroy Bhole.
MAC17101720	2.45	144.90	34.16	316.69	1.69	4.03	20.86	16.66	76.72	57.25	88.43	39.86	190.88	70.08	20.40	Ballymacilroy Bhole.
MAC18001810	2.34	161.19	38.95	299.88	1.08	4.54	18.67	16.57	74.44	35.46	59.34	27.79	207.92	30.35	20.40	Ballymacilroy Bhole.
MAC2040	4.53	92.72	32.66	228.01	4.51	7.08	19.57	15.28	91.76	105.88	127.82	34.52	223.35	252.23	33.76	Ballymacilroy Bhole.
MAC20802090	2.45	86.96	21.99	107.37	4.41	3.82	15.10	11.13	84.81	140.55	410.22	810.79	226.88	32.00	42.94	Ballymacilroy Bhole.
MAC21902200	1.92	79.78	23.49	288.02	3.20	5.05	13.22	11.32	77.24	129.17	412.13	845.08	240.27	81.45	41.13	Ballymacilroy Bhole.
MAC23202330	3.28	89.69	24.38	172.12	1.89	8.30	19.57	11.32	77.14	72.60	257.34	520.82	224.42	88.93	31.84	Ballymacilroy Bhole.
MAC240250	3.39	94.04	35.36	200.89	1.79	1.69	12.32	10.12	82.43	77.75	106.59	33.02	151.13	57.36	23.11	Ballymacilroy Bhole.
MAC24602470	4.33	113.15	33.06	515.79	9.34	8.00	23.74	17.67	91.86	70.56	80.15	244.03	310.34	221.14	47.47	Ballymacilroy Bhole.
MAC25102520	4.33	112.04	32.07	385.56	5.92	8.91	22.05	15.19	87.82	78.51	134.30	305.38	305.63	192.97	45.89	Ballymacilroy Bhole.
MAC370380	2.86	65.32	26.98	119.23	1.79	3.72	10.44	8.46	89.27	112.85	335.37	365.53	221.85	76.11	35.46	Ballymacilroy Bhole.
MAC620630	4.01	92.83	32.37	199.96	3.30	3.93	11.93	10.31	85.12	81.73	132.92	85.52	192.28	149.55	25.61	Ballymacilroy Bhole.
MAC680690	3.49	70.38	26.08	223.78	4.10	7.39	13.12	8.74	80.04	99.33	166.25	283.15	225.38	199.87	39.09	Ballymacilroy Bhole.
MAC740750	3.18	69.97	27.98	209.14	2.49	4.03	11.83	9.94	80.25	89.88	157.02	130.88	206.20	131.96	30.82	Ballymacilroy Bhole.
MAC850860	3.07	73.71	28.97	209.97	2.19	3.82	12.22	10.40	92.90	93.75	186.10	190.62	211.99	135.07	34.44	Ballymacilroy Bhole.
MAC880890	3.91	63.90	27.38	188.62	1.79	4.54	10.44	9.38	94.14	113.61	316.47	402.54	219.70	139.05	36.71	Ballymacilroy Bhole.
NEWBMQ	1.72	56.42	16.50	110.77	3.60	1.89	12.72	10.95	90.31	122.09	374.65	1074.80	244.67	62.99		Black Mtn Qry
UBIBQ	1.72	64.92	19.50	128.30	3.70	3.62	8.85	9.57	98.81	148.60	515.21	1470.48	246.59	87.28	36.60	Keely Mtn Qry
UBLFIBQ	3.28	104.76	23.79	250.08	5.01	7.59	11.33	12.70	97.88	151.39	352.89	841.66	261.49	99.13	37.62	Keely Mtn Qry
UBUFMAC	3.28	111.63	25.08	240.07	4.41	6.47	16.79	14.91	92.59	109.74	370.51	800.33	280.24	108.07	38.52	Macosquin

Antrim Samples

All samples from Wallace (1995) but reanalysed in Edinburgh for Nb,Zr and Y

	Sample	Nb*	Zr*	Y*	Delta Nb*
Lower	WH-1	2.23	85.80	23.99	-0.35
	WH-3	2.23	81.00	23.88	-0.31
	DNL-1	2.90	83.20	24.10	-0.21
	PL-43	6.21	240.10	21.76	-0.81
	PL-16	2.64	84.60	23.21	-0.28
	GBY-2	4.30	144.80	26.70	-0.46
	BH-1	3.05	179.40	47.87	-0.56
	BH-2	3.05	177.60	46.54	-0.56
	BH-4	2.13	103.30	28.79	-0.46
	BH-6	2.33	103.00	30.24	-0.39
	BH-9	2.13	72.80	21.98	-0.27
	PL-17	2.84	147.20	35.93	-0.54
	PL-19	2.84	151.00	37.94	-0.54
	JP-117	7.53	171.10	38.61	-0.21
	JP-2	1.52	94.80	27.56	-0.55
	PL-55	31.18	697.00	88.05	-0.44
	YB-1	29.10	549.40	94.40	-0.24
Causeway Tholeiites	A-1	4.27	92.00	27.12	-0.08
	A-2	3.96	93.80	27.12	-0.13
	A-3	3.96	93.20	26.89	-0.13
	A-4	3.96	93.40	27.12	-0.13
	A-5	3.96	94.80	27.12	-0.14
	A-6	4.17	94.20	27.23	-0.11
	A-7	4.17	95.00	26.89	-0.12
	A-8	3.96	91.50	26.45	-0.12
	JP-3	2.64	63.90	24.77	-0.02
	CHQ-2	2.30	65.20	24.70	-0.10
	CMH-5	3.00	72.00	25.10	0.18
	CMH-6	2.90	72.10	25.10	0.17
	CMH-7	7.80	147.70	37.50	-0.09
	PNB-5	7.40	149.30	40.00	-0.09
	PL-26	7.74	148.30	37.50	-0.09
	JP29	7.94	146.60	41.07	-0.03
	JP-25	3.86	90.80	28.45	-0.09
	JP-15	2.74	65.50	24.33	-0.03
	JP-22	2.64	62.90	24.77	-0.01
	JP-121	2.23	59.10	24.88	-0.03
	JP-12	4.27	98.90	29.46	-0.11
	JP-20	4.47	98.00	27.78	-0.10
	JP-48	2.54	65.60	24.99	-0.06
	JP-28	3.76	89.10	27.00	-0.11
	CH-1	2.95	73.30	26.45	-0.06
	CH-2	3.05	70.70	27.12	-0.01

	Sample	Nb*	Zr*	Y*	Delta Nb*
Causeway Tholeiites	DC	3.56	83.60	26.11	-0.10
	DC-2	3.05	69.20	25.78	-0.01
	JP-49	2.95	74.10	26.33	-0.07
	JP-95	2.74	67.90	25.44	-0.05
	JP-96	2.95	74.10	26.78	-0.07
	PL-1	14.06	249.20	44.30	-0.20
	PNB-6	1.30	52.30	28.60	-0.11
	PL-101	1.21	51.80	30.80	-0.10
Upper	PB-1	2.40	72.40	23.40	-0.19
	CMH-1	2.10	67.10	20.60	-0.24
	CMH-2	2.70	74.60	24.50	-0.15
	JP-91	3.05	71.20	33.14	0.07
	PL-10	4.07	61.60	21.53	0.14
	PL-42	2.03	34.40	12.38	0.10
	PL-14	2.33	85.70	24.55	-0.32
	BVA-0	3.05	119.70	24.77	-0.48
	BVA-1	2.84	119.40	25.55	-0.50
	BVA-2	2.84	120.90	25.78	-0.51
	BVA-3	2.74	121.80	25.66	-0.53
	BVA-4	3.15	122.10	26.45	-0.46
	BVA-5	3.05	121.60	25.89	-0.48
	BVA-X	3.05	116.40	24.66	-0.46

Small Isles samples

All Samples from P. Dagley. Nb, Zr and Y analysed in Edinburgh.

rock type	Sample	La	Ce	Nd	Nb	Zr	Y	Sr	Rb	delta Nb
coastal dyke	110	0.67	6.37	6.62	1.30	62.99	16.80	171.30	5.11	-0.47
coastal dyke	161	3.42	14.01	10.03	2.03	76.44	17.60	183.05	3.70	-0.42
coastal dyke	173	10.03	28.50	19.61	2.55	108.40	17.90	429.90	11.36	-0.61
coastal dyke	194	10.75	31.48	19.70	4.74	147.74	26.98	313.28	10.45	-0.43
coastal dyke	243	7.59	21.55	16.66	3.39	110.83	22.79	215.84	8.94	-0.41
coastal dyke	248	12.07	27.90	17.95	4.22	142.78	25.28	244.30	11.26	-0.48
Rum	300	5.55	23.93	16.02	5.06	109.31	19.30	390.41	6.62	-0.29
Rum	301	1.69	13.61	9.57	1.30	55.01	18.60	234.71	5.41	-0.32
Rum	306	20.31	45.47	26.51	7.77	215.08	32.37	256.98	38.15	-0.46
Rum	309	1.38	-0.78	3.49	0.57	17.59	3.13	52.00	0.08	-0.44
Rum	322	2.30	1.11	1.10	0.25	1.81	0.74	306.48	-0.23	0.53
Rum	324	1.99	5.58	2.39	0.57	7.98	1.64	254.72	0.08	-0.04
Rum	325	-2.39	0.61	3.03	0.57	9.50	3.04	208.42	0.68	0.06
Rum	401	15.02	46.66	29.55	9.44	218.42	22.49	740.78	4.91	-0.53
Rum	405	12.58	27.11	16.02	5.26	129.03	37.85	244.71	19.11	-0.14
Rum	406	36.50	77.62	42.91	7.67	218.32	40.15	439.49	30.29	-0.39
Rum	411	36.70	77.42	41.07	7.56	213.97	39.45	521.15	29.69	-0.39
Rum	416	10.14	31.97	20.25	5.06	113.66	33.76	399.28	8.64	-0.10
Canna dykes	505	7.39	23.14	15.00	2.86	80.79	30.27	241.41	6.22	-0.10
Canna dykes	513	10.54	26.42	18.69	4.85	130.24	32.47	355.66	5.31	-0.24
Canna lavas	530	11.15	26.51	17.12	2.76	92.93	24.38	541.88	8.34	-0.32
Muck dykes	601	5.55	16.79	11.87	3.39	90.50	27.78	355.87	3.70	-0.16
Muck dykes	613	4.74	19.57	15.83	3.39	97.38	25.18	498.06	3.70	-0.26
Muck dykes	645	1.89	11.93	10.95	1.61	103.95	29.37	189.45	1.59	-0.57
Muck dykes	649	6.27	20.76	15.56	3.88	130.93	51.09	227.96	5.54	-0.16
Muck dykes	671	22.86	53.81	33.24	7.87	169.58	44.74	309.88	32.71	-0.13
Muck dykes	689	6.57	15.60	11.04	2.45	89.39	18.30	214.71	2.90	-0.46
Muck dykes	695	15.53	38.72	21.91	6.53	142.87	35.64	292.13	27.88	
Muck dykes	712	6.37	13.22	12.52	2.34	99.60	19.20	184.91	7.73	-0.55
Muck lava	750	4.43	15.50	14.45	2.24	122.96	22.89	321.02	1.69	-0.67
Muck lava	752	7.28	22.55	16.20	3.80	109.31	18.70	354.53	3.50	-0.42
Muck lava	753	12.27	34.55	24.77	6.52	181.21	27.28	348.13	6.32	-0.46
Muck lava	755	9.22	18.08	15.46	4.53	111.03	25.78	259.46	3.00	-0.23
Muck lava	756	4.54	15.70	12.33	2.45	88.98	25.08	380.20	3.00	-0.33
Muck lava	757	9.42	23.74	15.09	4.64	120.33	24.78	295.55	7.13	-0.31
Muck lava	758	9.73	36.44	24.30	5.26	182.02	37.15	464.13	5.82	-0.43
Muck lava	759	11.25	29.29	23.94	5.26	182.52	35.76	473.21	7.03	-0.45
Muck lava	762	9.42	32.27	25.69	5.47	177.67	34.06	487.13	5.21	-0.43
Eigg dyke	800	4.64	12.32	10.95	2.55	88.58	20.19	233.99	0.98	-0.39
Eigg dyke	846	61.44	148.28	91.90	28.33	435.63	75.66	33.03	90.63	-0.15
Eigg dyke	853	3.72	20.56	16.11	3.49	136.31	29.17	249.25	1.38	-0.47
Eigg lava	900	9.12	26.81	18.78	3.70	113.15	21.79	432.17	8.23	-0.40
Eigg lava	908	7.18	16.89	13.07	2.13	80.59	19.50	337.93	14.28	-0.40
Eigg lava	947	9.83	35.45	26.42	5.06	181.01	34.76	562.40	4.71	-0.47
Eigg lava	951	6.17	16.09	14.17	2.34	117.60	21.79	303.28	1.59	-0.63
coastal dyke	039	8.81	23.24	15.65	4.01	126.90	19.99	332.05	7.63	-0.50
dykes cut lavas	402D	1.89	5.97	4.96	0.67	45.40	23.29	131.40	1.49	-0.36
dykes cut lavas	417D	4.54	14.80	13.71	2.03	91.81	26.48	212.03	2.69	-0.41
dykes cut lavas	418D	17.57	34.55	20.07	4.43	127.21	43.84	270.29	16.49	-0.14
Muck lava	754A	7.08	25.82	19.61	4.64	131.66	21.39	358.96	4.31	-0.44
Muck lava	754B	10.85	28.30	21.17	5.06	174.53	33.56	552.19	5.31	-0.46
Eigg dyke	8252/806	2.50	3.00	3.40	1.09	42.37	19.40	124.80	2.09	-0.16
Muck dyke	M1				4.07	131.17	54.43	239.49	5.37	-0.12
Muck lava	M11				5.28	177.79	36.02	478.23	5.57	-0.42
Muck lava	M2				2.76	80.64	30.87	284.89	2.76	-0.11
Muck lava	M3				12.76	301.33	47.91	472.63	19.91	-0.37
Muck lava	M4				3.87	107.34	26.98	232.36	2.56	-0.25
Muck lava	M6				18.32	347.85	44.82	528.11	49.20	-0.36
Muck lava	M8				4.98	174.81	35.10	413.68	5.47	-0.45
Muck lava	M9				16.60	316.73	42.08	511.31	40.58	-0.35

Small Isles samples

All samples from Emeleus (1997)

sample	Nb	Zr	Y	Zr/Y	Delta Nb	Ce	Ba
13846	7.71	167.34	36.79	4.55	-0.20	42.83	419.90
13847	5.69	142.38	35.10	4.06	-0.22	42.70	334.20
23766	9.12	241.30	32.86	7.34	-0.48	68.40	533.40
23772	4.88	149.94	26.11	5.74	-0.45	36.99	199.30
23778	28.02	418.02	42.41	9.86	-0.35	156.88	1588.70
23788	9.43	201.32	28.81	6.99	-0.37	71.65	689.20
C100	4.10	113.45	27.08	4.19	-0.27	32.92	231.50
C15	5.13	107.63	30.96	3.48	-0.08	31.72	316.00
C66	7.04	143.62	33.12	4.34	-0.16	69.80	724.20
C67	8.24	138.34	33.73			71.96	912.10
C82	5.05	124.19	30.44	4.08	-0.21	33.09	254.60
C85	5.22	135.29	31.14	4.35	-0.26	33.84	285.90
C88	4.96	123.17	31.48	3.91	-0.20	32.94	259.80
C99	4.62	118.91	26.38	4.51	-0.27	38.41	225.80
DU13848	5.05	113.18	30.53	3.71	-0.13	28.08	283.40
DU13852	17.32	329.50	44.18	7.46	-0.34	161.30	1905.30
DU13853	16.19	324.04	44.01	7.36	-0.36	158.33	1675.70
DU9868	7.12	217.82	22.84	9.54	-0.65	52.28	244.30
DU9871	9.89	201.17	36.66	5.49	-0.25	86.70	996.10
DU9873	5.48	124.28	29.06	4.28	-0.20	27.34	291.40
E622	6.00	179.42	30.70	5.84	-0.44	57.36	421.20
E644	5.48	147.78	32.52	4.54	-0.30	40.16	353.60
E651D	4.07	127.88	23.87	5.36	-0.43	24.27	108.20
EA1	25.18	556.46	46.95	11.85	-0.59	150.35	2841.50
EA28	14.12	526.85	17.14			141.68	1646.60
EA48	24.83	1001.50	50.57			164.71	1193.00
EA55	18.09	420.26	44.87	9.37	-0.52	190.87	1036.00
EA666	2.11	119.93	23.62	5.08	-0.66	25.20	52.10
HE7403D	2.15	85.82	20.61	4.16	-0.43		70.00
HE7409	1.24	51.23	24.54	2.09	-0.17	7.06	14.80
HE7412	21.12	325.52	41.42	7.86	-0.26	165.36	1499.10
HE7414	2.66	75.05	29.37	2.56	-0.09	6.60	162.60
HE7418	2.76	90.07	21.73	4.14	-0.34	10.28	73.00
HE7422	3.46	126.64	24.32	5.21	-0.48	35.48	172.30
HE7434	1.14	55.27	25.89	2.13	-0.25	1.86	56.60
HE7438	1.85	78.57	18.25	4.31	-0.47	15.29	114.50
HE7457	3.56	90.38	28.70	3.15	-0.12	23.50	276.10
HE7468	2.25	101.98	19.48	5.23	-0.58	21.22	379.40
HE7469	1.85	99.19	19.93	4.98	-0.63	27.41	179.60
HE7472	7.81	223.10	30.19	7.39	-0.51		
HM75139	3.97	106.13	26.56	4.00	-0.24	25.05	135.20
HM75140	4.07	104.26	26.45	3.94	-0.22	22.13	88.90
HMD111	2.25	105.19	22.07	4.77	-0.55	30.89	321.60

sample	Nb	Zr	Y	Zr/Y	Delta Nb	Ce	Ba
HMD119	3.56	92.56	31.84	2.91	-0.10	18.93	198.10
HMD2	1.64	66.25	13.42	4.94	-0.50	12.05	279.80
HMD3	3.56	126.84	24.09	5.27	-0.47	20.01	37.80
M127	15.59	351.70	38.48	9.14	-0.50	109.57	1115.70
M141	3.77	108.92	27.35	3.98	-0.27	12.37	78.40
M144	7.29	189.60	29.32	6.47	-0.42	53.04	483.80
M31	5.13	175.26	33.64	5.21	-0.45	47.08	285.20
M620	5.65	115.49	25.61	4.51	-0.17	25.46	417.00
M624	3.67	127.80	21.63	5.91	-0.51	27.04	
M97	16.45	334.31	40.47	8.26	-0.41	109.15	1112.90
MD101	18.01	513.25	56.97	9.01	-0.59	132.84	975.60
MD37	1.85	93.39	19.48	4.79	-0.59	15.60	42.80
MD4	6.34	72.00	18.70			19.69	1738.30
MD41	2.25	82.30	19.03	4.32	-0.41	9.60	94.50
MD5-7A	2.86	78.47	27.24	2.88	-0.12	16.74	120.00
MD56C	3.67	93.18	29.04	3.21	-0.13	20.29	20.29
SR139	6.52	189.60	24.14	7.85	-0.55	50.87	313.60
SR149	10.15	211.34	39.00	5.42	-0.25	85.46	926.50
SR156	14.17	219.03	23.53	9.31	-0.34	68.67	381.70
SR157	4.53	134.37	24.92	5.39	-0.41	25.35	96.80
SR158	6.69	124.84	29.67	4.21	-0.11	65.52	689.20
SR160	6.69	214.40	23.45	9.14	-0.65	57.56	307.10
SR161	9.80	212.55	37.96	5.60	-0.28	89.47	883.10
SR162	9.97	212.46	37.27	5.70	-0.28	90.74	983.10
SR163	9.89	207.55	38.74	5.36	-0.25	84.97	1021.40
SR164	10.32	226.98	39.43	5.76	-0.30	92.06	998.30
SR165	7.91	227.32	40.72	5.58	-0.41	84.60	920.50
SR166	9.02	201.63	36.66	5.50	-0.29	75.31	928.90
SR185	10.32	214.68	39.52	5.43	-0.25	83.39	938.10
SR187	14.38	282.31	43.84	6.44	-0.30	127.26	1466.00
SR189	10.03	250.42	44.77	5.59	-0.35	109.77	1212.90
SR190	3.97	104.48	20.86	5.01	-0.32		
SR213	4.96	111.88	30.27	3.70	-0.14	32.38	304.00
SR215	6.17	124.00	33.21	3.73	-0.09	34.11	329.20
SR217	5.08	125.91	23.19	5.43	-0.33	27.54	83.10
SR226	9.71	215.60	39.00	5.53	-0.29	94.25	890.00
SR230	12.66	306.25	54.43	5.63	-0.33	142.10	1474.00
SR232	11.95	290.61	48.36	6.01	-0.36	127.35	1407.60
SR235	5.28	144.45	33.08	4.37	-0.29	44.73	325.40
SR237	7.91	224.42	42.07	5.33	-0.38	86.93	903.10
SR240	9.54	205.05	38.31	5.35	-0.26	92.19	868.00
SR303B	24.66	550.17	44.35	12.40	-0.61	158.07	2664.90
SR333	13.69	321.26	33.38	9.62	-0.54	118.20	992.60
SR486	11.53	292.95	22.67	12.92	-0.69	59.93	1072.50
T213	69.57	1697.86	140.61	12.08	-0.64		
TISW-4B	58.40	935.19	116.47	8.03	-0.30		

Arran samples
Collected by LMC

Sample	La	Ce	Nd	Nb	Zr	Y	Sr	Rb	delta Nb	Zn	Cu	Ni	Cr	V	Ba	Sc
AD32	7.90	21.85	18.13	2.45	153.60	20.59	291.84	2.49	-0.86	128.16	96.11	378.69	553.61	239.31	41.33	34.56
AD29	3.42	19.37	16.66	1.92	127.51	23.79	226.57	3.90	-0.75	81.91	95.36	424.12	651.37	224.20	24.23	28.21
AD27	1.58	12.12	13.53	1.82	122.35	23.19	218.11	2.49	-0.75	100.16	105.13	436.86	788.36	233.42	25.88	36.14
AD30	2.91	14.51	15.37	2.45	147.23	25.38	236.16	8.64	-0.74	84.60	98.90	275.81	447.10	217.88	40.75	27.76
AD89	4.74	19.57	16.48	2.66	144.90	28.37	259.87	2.59	-0.65	78.59	70.67	210.20	322.38	216.60	37.05	21.98
AD46	2.70	19.57	14.54	4.64	166.04	23.09	295.24	5.41	-0.60	77.76	93.00	313.40	580.76	268.13	66.78	30.93
AD71	2.40	10.64	9.57	2.24	106.28	23.89	519.92	25.66		96.32	116.61	125.80	104.93	399.59	790.60	51.10
AD33	1.69	10.24	10.95	1.82	90.90	22.09	321.22	3.00	-0.52	72.78	101.05	245.34	60.67	206.52	55.51	17.45
AD70	4.94	14.11	12.88	1.72	94.65	26.38	254.92	3.30	-0.51	80.35	86.23	125.06	41.16	287.95	52.60	31.16
AD65	5.15	21.45	15.92	3.18	139.24	30.47	481.25	19.32	-0.51	121.83	92.03	115.08	15.31	336.38	463.81	40.79
AD37	2.70	8.95	8.83	2.03	102.94	27.08	200.79	2.29	-0.50	80.97	106.20	179.10	292.21	298.34	41.62	42.26
AL3	3.42	20.66	17.03	3.80	147.53	32.07	487.13	12.67	-0.46	77.03	11.20	170.92	182.07	201.06	80.87	37.84
AD60	3.11	8.35	9.94	1.72	88.17	26.48	219.66	2.29	-0.45	77.35	92.35	116.25	65.40	289.88	42.49	26.29
AL1	4.03	20.26	15.00	3.59	129.13	28.18	267.40	93.55	-0.42	91.66	78.72	345.35	254.19	227.63	274.18	17.79
AD26	4.23	13.12	12.61	2.66	102.53	24.68	204.19	2.09	-0.42	75.38	81.08	360.21	545.86	168.06	17.04	18.92
AD72	-1.27	3.00	3.03	0.46	33.97	19.60	138.51	0.68	-0.35	67.29	175.01	354.80	790.57	284.20	39.58	47.59
AD19	4.23	21.45	16.02	5.26	138.13	28.08	201.72	3.40	-0.32	78.69	89.78	146.72	215.46	297.38	59.30	42.03
AD56	4.94	13.61	10.03	3.91	98.19	19.20	223.16	4.91	-0.31	74.65	108.35	411.60	744.40	268.24	48.32	26.06
AD48	4.03	16.59	16.11	3.70	104.56	26.48	193.57	1.28	-0.26	85.23	119.40	190.67	252.68	353.73	35.21	55.52
AD58	3.82	10.44	10.86	3.91	89.79	18.50	216.67	3.50	-0.25	85.85	102.34	527.32	764.82	242.31	45.60	23.79
P014	5.86	25.82	18.41	6.31	157.24	35.86	418.87	2.49	-0.25	83.26	53.06	86.73	31.41	199.67	108.84	17.68
AD23	4.03	12.52	11.04	2.97	99.60	32.27	199.55	3.10	-0.24	93.31	112.85	168.80	447.20	374.20	33.27	41.92
AD20	3.52	10.93	7.63	2.76	80.69	22.59	184.08	1.49	-0.23	75.89	104.59	164.66	246.84	280.88	37.35	35.24
AD57	16.24	30.78	21.17	4.33	109.01	26.48	262.86	3.00	-0.23	257.36	130.14	346.52	763.21	379.34	63.38	45.55
AD12	2.09	7.76	7.54	0.99	47.02	22.89	120.57	1.08	-0.23	66.46	108.13	218.48	352.55	247.13	46.77	31.05
AD67	5.96	15.10	13.25	3.70	116.69	37.15	169.75	2.59	-0.22	112.91	117.69	82.59	136.51	512.51	112.92	54.61
AD54	16.24	35.74	18.41	7.77	152.39	31.17	201.41	20.93	-0.19	77.45	59.61	76.12	70.73	213.60	257.28	22.55
AD41	21.13	48.64	28.36	11.53	239.25	52.12	120.57	43.99	-0.19	85.74	65.19	78.45	142.75	142.46	379.00	28.89
AD45	2.20	10.83	7.82	1.82	65.52	25.98	155.42	1.38	-0.19	72.47	112.64	148.52	312.92	319.98	36.96	61.07
AD82	4.64	17.29	12.98	3.59	102.74	31.97	169.75	2.69	-0.18	90.10	107.27	383.36	467.31	332.84	36.37	36.82

Sample	La	Ce	Nd	Nb	Zr	Y	Sr	Rb	delta Nb	Zn	Cu	Ni	Cr	V	Ba	Sc
AD15	14.51	31.38	17.49	6.10	150.77	40.65	195.53	22.34	-0.18	77.66	118.01	156.38	247.85	265.88	31.32	51.55
AD43	1.48	4.19	6.35	0.99	44.29	22.99	116.96	0.88	-0.17	72.06	128.96	283.67	547.07	256.88	20.35	41.58
AD47	6.17	16.19	13.71	1.30	67.44	41.14	193.57	2.29	-0.17	298.73	109.21	121.87	287.98	414.69	47.45	70.92
AD86	3.01	8.55	8.00	2.13	76.75	31.87	162.84	5.92	-0.17	89.27	145.06	109.35	126.86	369.80	50.17	46.45
AD44	-1.37	3.00	5.42	1.19	44.89	19.99	116.34	1.49	-0.16	72.89	135.83	259.04	547.27	269.95	21.61	43.62
AD15	1.18	4.48	6.07	5.58	136.21	38.25	200.27	19.32	-0.16	80.25	66.80	98.31	122.53	234.17	356.75	32.74
AD69	3.82	14.01	14.54	3.80	115.58	41.94	197.28	5.31	-0.15	96.53	123.59	82.81	123.54	517.87	100.68	51.89
AD68	6.37	15.30	13.25	3.80	113.35	41.14	173.88	3.50	-0.14	101.40	120.69	80.05	146.67	510.91	77.95	47.81
AD51	0.77	10.64	6.71	1.40	48.84	21.09	137.17	1.28	-0.14	63.87	122.84	285.26	606.71	249.59	25.88	40.45
AD42	20.31	43.09	25.78	6.52	132.37	32.37	426.09	9.14	-0.13	124.01	74.43	86.31	121.32	318.48	458.95	52.57
AD14	15.22	28.60	15.92	6.20	133.48	34.96	203.06	23.75	-0.13	81.70	81.19	63.17	70.63	220.45	406.98	38.86
AD64	3.31	8.45	7.63	1.92	64.51	28.47	188.11	3.00	-0.11	75.89	104.59	147.99	181.17	285.91	48.03	53.02
AD5	17.97	35.55	18.87	7.87	160.68	41.44	309.36	25.76	-0.11	102.96	25.05	16.98	15.41	342.91	529.28	42.26
AD4	15.22	35.55	20.99	8.50	164.93	41.94	484.96	13.07	-0.09	112.19	21.51	11.89	15.11	316.34	446.03	35.69
AD3	15.12	27.71	16.84	7.87	154.61	39.95	312.36	25.96	-0.09	107.73	26.34	16.88	16.32	364.98	654.01	43.05
AD6	15.43	30.68	15.37	7.35	133.68	32.07	152.53	34.83	-0.09	52.77	82.48	76.86	182.98	215.63	328.29	36.03
AD63	0.97	6.77	6.25	1.72	53.29	22.99	159.85	2.29	-0.09	73.92	106.63	158.71	194.64	285.59	47.93	47.25
AD16	10.14	31.77	17.67	3.49	93.33	34.36	220.59	6.52	-0.09	89.37	69.38	102.13	120.02	222.49	317.90	32.52
AD76	1.28	8.25	7.36	2.13	58.75	22.59	141.09	3.00	-0.08	70.19	152.68	181.22	336.16	321.59	36.37	52.68
AD40	2.60	11.43	9.11	2.55	68.56	26.18	100.36	27.47	-0.07	100.68	161.48	126.76	352.15	429.05	169.36	81.80
AD22	17.36	41.10	22.55	8.50	152.49	38.05	331.84	4.61	-0.07	110.94	59.40	117.42	124.54	285.16	356.07	42.15
AD39	19.19	40.01	21.73	9.86	167.25	39.35	265.44	28.38	-0.07	105.96	46.84	27.07	34.32	359.63	425.43	42.37
AD84	27.75	51.72	27.34	10.80	171.20	37.45	222.55	25.46	-0.07	132.93	72.06	72.83	124.04	334.45	369.58	46.11
AD21	0.67	4.88	6.07	1.51	50.56	25.08	156.35	1.99	-0.07	74.13	98.15	143.74	208.42	251.42	31.13	39.43
AD10	8.30	22.55	19.06	5.16	135.10	51.42	201.51	5.41	-0.06	108.04	86.99	58.07	66.91	571.65	165.57	46.11
AD73	9.63	24.93	14.17	5.58	117.80	36.26	260.59	11.06	-0.06	95.70	37.71	48.62	83.30	279.70	249.51	45.77
A5	14.72	38.62	20.07	8.81	154.01	38.85	268.64	27.58	-0.05	95.60	40.72	21.87	26.68	370.88	406.39	37.05
AD31	35.08	76.33	32.87	16.75	181.81	27.58	119.95	114.20	-0.05	97.77	12.60	52.76	101.31	80.96	479.74	12.58
AD25	13.29	34.26	22.83	7.87	142.17	37.65	326.28	5.82	-0.05	106.17	52.85	115.08	118.71	250.02	347.23	31.72
AD34	0.16	6.37	6.07	1.40	47.83	25.28	190.48	1.38	-0.05	67.70	94.61	151.28	148.38	215.74	59.49	37.50
AD24	1.89	17.38	12.33	3.59	85.65	30.87	165.52	6.62	-0.04	80.15	108.13	110.09	193.04	307.56	90.00	41.13
AD55	4.74	9.54	8.00	2.55	72.40	31.57	177.28	6.72	-0.04	87.61	87.52	126.65	187.60	263.63	77.66	40.68
AD85	16.96	39.42	22.65	9.54	152.39	35.66	283.28	12.06	-0.04	90.51	65.84	74.74	101.11	318.48	345.19	39.66
AD7	15.53	29.59	15.37	7.25	131.56	35.66	152.22	31.71	-0.04	71.43	101.05	78.24	185.19	253.67	253.20	42.60

Sample	La	Ce	Nd	Nb	Zr	Y	Sr	Rb	delta Nb	Zn	Cu	Ni	Cr	V	Ba	Sc
AD35	7.39	14.21	10.03	2.76	71.59	29.17	234.20	4.81	-0.03	88.44	100.08	147.88	198.47	258.17	136.24	37.16
AD11	3.52	6.17	6.53	2.34	68.05	31.67	152.53	1.89	-0.03	86.57	116.61	92.57	164.77	326.09	55.71	44.98
AD75	3.52	10.93	8.37	2.03	53.08	22.39	162.74	1.79	-0.02	67.29	144.95	174.00	341.19	320.63	29.77	51.32
AD61	4.84	19.47	13.90	4.74	107.49	39.35	179.75	5.11	-0.02	96.94	111.14	113.81	252.68	428.19	121.18	46.45
AD36	5.35	14.01	7.82	2.76	68.15	27.58	210.89	1.99	-0.01	91.14	97.50	159.99	209.23	256.88	104.76	31.72
P008	2.70	9.05	9.20	3.39	74.42	26.58	155.83	4.21	-0.01	88.96	135.93	181.33	130.27	273.38	55.51	23.23
AD78	0.67	8.16	7.54	2.24	57.33	24.38	150.57	2.59	-0.01	71.43	158.37	186.63	345.81	331.77	35.11	59.14
AD50	-0.35	14.21	8.56	2.45	54.80	20.29	152.53	1.49	-0.01	65.01	119.62	178.78	277.42	262.88	30.16	51.89
AD38	1.48	6.27	6.90	1.72	50.86	25.78	186.87	0.78	0.00	69.57	115.00	140.56	197.86	275.63	47.25	50.31
AD59	0.16	5.48	5.70	1.40	41.46	21.99	132.22	1.18	0.02	70.40	111.89	222.41	333.34	246.70	20.64	44.41
AD77	0.36	9.64	6.44	2.24	55.11	24.18	138.51	2.80	0.02	76.00	144.74	167.84	298.04	284.84	32.00	37.28
AD17	10.54	20.96	14.54	2.24	52.98	22.49	163.98	1.08	0.02	85.12	88.27	82.17	119.71	293.63	198.60	39.43
AD80	0.26	2.80	2.94	2.55	50.96	18.90	155.63	1.69	0.04	72.99	129.92	175.49	270.68	287.74	25.49	58.01
P080	11.56	20.86	14.63	7.67	114.06	32.47	158.82	4.21	0.07	87.51	88.06	118.90	122.63	294.38	129.05	42.15
AD66	1.79	9.05	7.82	3.49	71.99	29.77	133.35	1.28	0.07	69.26	123.59	162.85	138.22	245.52	40.07	39.77
AD1	14.11	35.84	20.62	8.92	137.93	43.14	289.77	10.85	0.09	97.98	46.73	53.72	84.31	172.99	309.54	47.36
AD88	1.69	6.27	7.17	2.34	52.58	26.18	126.65	3.10	0.11	79.21	132.82	404.70	704.27	273.59	43.56	51.10
AD49	3.31	5.58	6.25	2.86	48.84	18.30	162.12	1.38	0.12	68.12	116.08	159.99	217.38	254.84	39.58	51.66
P049	0.67	9.94	5.89	2.55	52.38	24.48	105.00	3.00	0.12	82.22	116.61	390.68	733.44	243.49	51.14	45.77
AD87	3.11	3.69	5.33	2.34	46.31	22.89	126.34	2.19	0.16	75.17	106.41	384.95	715.54	233.84	45.60	38.07
AD2	66.63	121.98	54.42	19.57	201.74	54.71	59.32	116.12	0.21	43.44	-0.39	5.20	8.68	-4.43	1206.27	2.95
AD13	3.21	7.06	7.08	3.70	57.03	25.58	139.44	2.09	0.23	71.85	122.19	221.88	499.50	279.06	104.08	40.68

Ardnamurchan samples
Collected by LMC

Sample	La	Ce	Nd	Nb	Zr	Y	Sr	Rb	delta Nb	Zn	Cu	Ni	Cr	V	Ba	Sc	notes
AN2	31.00	72.46	38.95	12.91	276.25	59.98	263.00	57.39	-0.20	138.94	31.81	6.79	7.67	262.13	804.68	44.07	c1 cone sheet
AN3	42.81	91.02	46.13	16.74	407.88	68.43	228.88	61.38	-0.36	134.17	40.61	7.22	9.18	189.06	988.87	31.39	cone sheet c1
AN4	3.42	7.86	5.61	1.03	24.31	8.08	397.66	2.95	-0.07	51.63	86.66	63.80	337.26	128.10	118.36	47.70	c3 eucrite
AN5	3.62	6.47	4.23	0.54	20.94	7.85	363.13	2.45	-0.24	45.41	122.94	65.29	250.57	113.10	142.75	40.22	c2 eucrite
AN6	1.48	3.00	2.11	0.44	5.52	1.19	342.76	1.46	0.03	33.90	99.87	116.46	426.38	52.89	53.08	18.47	c3 eucrite
AN7	1.99	6.47	4.41	0.64	22.88	9.63	403.06	3.65	-0.16	31.72	93.96	58.07	314.73	110.42	98.64	52.12	c3 eucrite
AN8	3.21	3.19	1.65	0.15	6.44	1.52	371.28	1.46	-0.48	52.04	138.19	124.32	55.55	41.64	78.15	4.76	c3 eucrite
AN9	2.70	2.50	2.48	0.44	12.87	3.41	324.63	2.15	-0.26	23.63	59.93	66.46	1303.42	86.64	61.73	37.39	biotite eucrite c3
AN10	3.31	5.77	4.87	0.73	15.02	2.63	405.51	2.65	-0.27	49.04	64.66	100.54	857.15	251.09	120.69	10.43	qtz gabbri c3
AN11	19.50	47.45	24.77	7.70	541.05	40.75	342.15	21.70	-1.14	86.99	151.07	50.43	55.44	492.80	290.31	35.01	fluxion gabbro c3
AN12	61.24	122.97	54.05	22.73	593.34	42.53	282.35	114.63	-0.73	86.89	108.02	9.13	10.49	98.96	945.74	13.26	qtz gabbroi c3
AN14	5.25	18.38	11.87	3.39	87.93	32.53	272.17	13.32	-0.07	115.30	111.35	40.34	65.20	600.15	176.55	61.63	hyp gabbro c2
AN15	3.62	6.47	5.33	1.03	34.52	15.86	306.09	3.45	-0.10	60.86	169.42	78.77	241.31	310.56	113.70	45.89	hypp gabbro c2
AN16	11.97	30.19	17.49	5.05	108.87	30.08	259.23	5.15	-0.11	106.17	271.29	70.81	94.87	576.47	158.29	53.25	hyp gabbbro c2
AN17	6.27	24.13	14.45	3.97	101.21	33.75	305.37	7.94	-0.10	83.15	130.03	46.60	79.38	314.09	229.40	40.11	hyp gabbro c2
AN18	0.57	5.38	2.94	0.73	25.02	13.08	322.79	8.04	-0.05	72.89	371.77	86.52	105.23	888.68	146.73	72.51	c2
AN19	31.31	64.13	25.50	10.85	243.46	20.53	262.59	75.34	-0.60	34.62	2.08	11.78	42.87	46.14	1009.46	7.59	cone sheet c1
AN20	12.68	26.91	15.92	3.48	103.96	27.30	290.40	14.92	-0.27	76.10	118.76	77.39	151.70	226.02	296.72	36.82	basalt lava
AN21	26.83	61.55	34.90	10.94	230.09	56.20	257.91	37.15	-0.15	144.02	114.89	16.98	9.08	476.73	661.69	54.04	dolerite dyke post c3
AN22	14.72	35.15	23.94	5.37	154.01	48.63	258.53	17.30	-0.18	128.57	158.15	35.46	26.28	549.15	286.42	54.95	cone sheet c1
AN23	22.55	55.19	32.87	10.26	219.06	53.53	227.86	30.27	-0.15	158.54	172.97	18.58	14.31	576.90	520.25	58.12	basalt lava
AN24	33.75	67.90	39.59	12.71	263.17	60.09	262.80	33.16	-0.17	139.77	85.05	17.30	18.33	339.91	686.46	42.83	cone sheet c1
AN25	3.21	13.91	12.24	2.70	95.69	17.86	225.11	1.46	-0.48	84.40	125.20	184.94	284.76	295.66	22.00	35.01	cone sheet c1
AN26	1.79	10.44	11.60	1.81	75.06	18.52	154.62	1.66	-0.44	94.66	127.78	167.95	273.00	345.59	40.65	40.22	cone sheet c1

Offshore samples
BGS collection

Sample	Location	Depth	Nb*	Zr*	Y*	Sr*	Rb*	DNb	Latitude	Longitude	Age (Ma)	La	Ce	Nd	Zn	Cu	Ni	Cr	V	Ba	Sc
HTS	Hebrides Terrace		5.97	99.33	33.20	354.34	6.38	0.08			Pre 60.0	7.12	17.94	12.71	87.70	60.40	70.65	24.96	219.20	207.90	28.85
57-12/18	Anton Dohrn	3.42 m	18.60	194.44	39.00	325.88	10.87	0.08	57 33.62	11 05.87	Maastrictian (Pre 65)	13.11	32.75	22.69	107.60	63.80	94.16	76.38	344.50	116.70	38.29
57-13/66	Rockall	0.80-0.85 m	13.96	158.54	35.39	207.80	3.69	0.09	57 21.28	12 57.81	56+/-2	12.21	32.14	24.34	117.20	681.00	85.39	140.34	435.50	54.70	49.47
57-14/53	Rockall	0.80-0.85 m	15.27	273.59	31.13	6.29	49.52	-0.38	57 34.14	13 19.80	56.5+/-0.1	36.80	96.75	44.98	90.50	2.60	5.53	11.70	-0.40	74.60	12.36
58-14/42	George Bligh Bank	4.55-4.6 m	15.47	212.23	33.09	566.83	10.57	-0.14	58 57.72	13 45.45	no age	13.02	38.22	27.92	90.70	28.90	61.44	18.91	275.30	80.30	17.46
58-14/50	Rockall		19.41	270.32	57.05	153.74	35.97	-0.03	58 04.13	13 20.45	no age	22.85	61.96	35.39	106.80	39.40	51.58	29.96	128.30	272.00	18.33
59-11/12A	Rosemary Bank	1.10 m	125.30	442.95	20.08	1672.35	81.01	-0.04	59 18.41	10 04.99	Late Maastrictian (Pre 65)	132.75	273.67	100.42	122.10	34.20	134.15	130.25	78.10	2291.90	1.51
59-11/12B	Rosemary Bank	3.0 m	131.87	462.28	22.16	1499.39	54.80	-0.02	59 18.41	10 04.99	Late Maastrictian (Pre 65)	138.30	289.19	104.78	124.50	36.00	152.68	130.45	77.50	2206.80	-0.22
85/5B	Hebrides Shelf	42.60 m	7.49	123.97	38.45	212.37	6.98	0.05	58 28.77	7 52.35	42.60	6.67	15.81	13.48	87.20	59.10	84.85	27.94	156.70	78.60	26.25
85/7	Hebrides Shelf	30.37 m	3.14	71.00	33.20	98.26	1.00	0.08	59 23.23	6 23.55	57.50	2.47	7.99	8.54	104.30	213.90	86.04	146.78	404.90	21.00	64.44
88/10	Hebrides Shelf	132.85 m	31.84	342.93	103.00	325.78	9.37	0.23	58 58.23	6 57.05	Pre 53.1+/-0.5	36.45	90.26	56.13	185.30	57.50	64.04	30.05	257.90	475.80	44.48
90/4	Hebrides Shelf	14.9 m	2.44	58.32	27.63	125.18	0.30	0.06	59 22.08	6 21.26	46.4+/-2.8	2.56	7.08	7.09	94.00	166.30	93.30	181.36	381.80	10.70	67.81
90/7	Hebrides Shelf	10.4 m	18.91	400.92	55.85	237.07	8.67	-0.37	58 28.15	7 38.16	62.4+/-1.3	17.94	50.29	33.64	135.00	75.30	122.77	202.50	227.00	284.30	42.42
90/10	Hebrides Shelf	9.20 m	22.75	367.89	53.44	637.45	15.95	-0.24	58 07.94	8 05.66	55.8+/-0.7 or 54.4+/-0.7	40.20	111.67	66.30	131.70	13.90	4.55	8.34	147.00	648.50	24.08
90/18	Rosemary Bank	39.65 m	6.68	87.16	22.05	182.80	5.39	0.08	59 14.97	10 10.04	post 55.0	3.90	10.23	11.35	89.50	116.40	179.77	183.67	348.90	41.50	38.94
163A	NE Rosemary Bank	3535 m	18.10	198.43	31.45	224.26	86.98	-0.04			post 55.0	30.19	88.13	33.64	100.90	21.40	65.12	141.88	138.20	312.00	28.64
163B	NE Rosemary Bank	3594.5 m	18.10	198.94	31.13	256.48	80.71	-0.04			post 55.0	31.17	95.64	36.45	97.30	21.40	68.81	141.97	146.40	249.10	29.07
94/2	Rockall (s)	22.15 m	2.76	77.25	25.95	291.20	2.46	-0.14	56 54.24	13 34.51	Pre 55.5-44.0										
94/3A	Rockall	47.3 cms?	8.21	104.77	47.34	455.01	1.25	0.32	57 10.74	13 12.52	Pre 55.0										
94/3B	Rockall	209.65 m	7.71	121.51	42.88	259.13	2.06	0.13	57 10.74	14 12.52	Pre 55.0										
94/5	Rockall	29.96 m	14.98	275.14	58.78	329.38	19.51	-0.14	57 30.19	13 09.14	Post 56.5+/-0.1										
94/6	Rockall (n)	21.1 m	11.55	142.26	69.76	368.07	8.98	0.36	58 13.05	13 33.05	61-55										
94/7	George Bligh Bank	22.65 m	31.55	313.03	48.26	599.38	12.19	0.00	58 56.42	13 14.64	Pre 56										
HTN	Hebrides terrace north		4.27	85.17	30.31	419.15	7.14	0.03							95.18	180.37	154.25	187.50	270.91	120.11	37.05

Anglesey dyke samples collected by R Bevins

Sample	Nb*	Zr*	Y*	Sr*	Rb*
3827	2.8	97.8	26.0	171.4	10.2
3209	4.8	95.9	30.1	183.5	16.4
3317	6.6	98.9	35.1	248.2	12.8
3824	4.5	76.8	22.3	144.7	6.5
3228B	3.3	73.6	25.6	196.2	11.3
3821	3.3	67.4	21.0	155.4	6.8
3226	7.8	165.4	32.1	317.6	42.1
3231	9.6	157.0	43.5	303.5	41.5
3822	3.5	147.7	23.3	292.3	11.3
3309	1.05	86.6	24.4	282.1	17.6
3368	3.3	74.9	26.0	145.5	13.6
3330	3.5	75.7	22.6	169.2	4.6
3333	1.79	70.5	26.7	131.3	4.1
3245	6.5	86.6	30.6	283.3	13.2
3316	4.7	96.8	31.2	282.3	11.9
3308	2.2	159.5	45.5	199.7	4.8
3369	3.3	77.1	27.9	212.2	12.3
3343	4.2	104.1	25.9	172.7	6.5
3230	1.20	96.9	27.5	352.7	7.4
3213	1.40	109.9	31.2	218.8	5.7
3249	7.3	97.5	31.5	271.0	7.9
3331	6.3	103.5	22.5	259.1	7.7
3344	3.2	96.7	24.9	164.9	5.0
3324	4.4	91.7	29.4	188.7	6.0
3212	1.27	108.0	30.7	399.9	8.5
3220	2.5	69.3	39.1	90.4	69.6
3338	3.5	118.6	21.7	168.4	4.1
3310	9.0	114.9	37.3	289.6	18.3
3348	4.5	183.5	25.0	334.9	11.0
3351	2.4	66.6	24.9	111.8	6.0
3346	4.9	202.7	27.6	327.1	12.2
3228A	2.7	63.2	22.6	217.7	10.5
3329	2.1	90.9	22.1	153.7	4.5
3334	2.5	77.9	25.0	189.4	2.8
3205	2.4	56.3	20.2	206.0	10.3
3347	2.8	77.6	21.1	104.3	4.0
3345	3.2	96.0	24.4	161.5	6.1
3206	11.4	224.6	71.9	228.7	7.9
3356	38.3	118.0	22.0	407.1	38.3
3232	21.6	244.2	42.4	181.5	84.6

Well	9/23B-24					
Sample	Nb	Zr	Y	Sr	Rb	Zr/Nb
1620.25	16.5	146.3	11.0	211.0	39.2	8.89
1620.3	24.3	242.0	64.8	473.5	2.2	9.94
1620.75A	20.4	201.0	73.1	502.8	1.9	9.85
1620.75	8.6	69.8	53.9	463.6	7.9	8.13
1621	21.7	212.5	72.1	567.6	2.0	9.79
1621.6	12.4	139.7	14.3	262.7	26.2	11.24
1621.75	14.8	138.1	52.0	556.5	16.0	9.30
1621.8	13.9	140.0	22.3	422.3	39.4	10.04
1622	15.2	139.3	40.2	379.4	5.5	9.19
1622.4	18.0	159.3	66.2	438.7	12.0	8.86
1622.5	19.4	204.6	25.2	314.2	23.2	10.55
1623.3S	7.1	126.5	13.1	225.3	5.8	17.89
1623.3M	15.4	148.5	21.1	252.5	37.9	9.67
1623.5A	36.3	342.5	103.9	375.4	2.0	9.44
1623.8A	37.5	343.0	104.7	314.9	3.2	9.15
1623.8A	25.1	224.6	74.2	287.4	25.6	8.97
1623.8B	19.6	177.6	18.7	214.6	48.4	9.06
1624	25.8	244.0	26.3	286.0	45.6	9.47
1624.25	41.3	379.9	105.8	466.3	3.0	9.19
1625	18.9	170.9	27.4	267.4	49.8	9.05
1625	22.6	189.8	97.9	365.9	2.2	8.39
1625.3	27.6	234.8	34.1	269.6	40.4	8.51
1625.6A	15.8	154.3	20.7	191.3	48.7	9.79
1625.6B	18.4	169.6	25.1	214.1	44.9	9.23
1626.5	29.2	267.2	73.5	396.3	21.2	9.15
1626.85	19.2	191.5	35.6	251.4	51.8	9.98
1627.45	28.2	270.9	72.7	407.7	2.6	9.61
1627.5	20.3	193.4	59.5	398.7	1.6	9.53
1627.9	21.0	214.1	33.8	236.2	46.2	10.19
1628	19.6	190.0	23.7	244.1	46.9	9.70
1629.6	13.9	149.3	17.1	230.8	33.4	10.71
1630.25S	30.6	293.0	101.3	300.1	2.1	9.57
1630.25M	29.2	284.1	74.8	293.2	9.6	9.73
1630.85	19.2	191.9	22.9	232.8	33.2	10.00
1631.3M	25.1	234.9	23.8	244.3	30.4	9.38
1631.35	21.5	207.8	23.5	216.7	31.5	9.66
1631.3S	21.8	211.2	77.0	304.5	12.1	9.68
1631.4	25.4	250.8	66.5	238.7	2.1	9.89
1631.7	26.2	263.1	62.1	289.4	2.3	10.06
1631.9	17.1	164.9	19.9	182.2	44.4	9.66
1632.2	28.6	267.0	68.2	237.8	5.4	9.34
1632.65	31.0	274.9	74.9	321.5	3.4	8.86
1633	21.3	193.6	71.1	402.5	3.3	9.08
1633.5	11.5	155.2	31.0	329.7	12.5	13.48

Sample	Nb	Zr	Y	Sr	Rb	Zr/Nb
1633.5	28.1	261.8	55.4	346.5	18.4	9.32
1636.2	29.4	273.6	64.9	263.4	5.1	9.31
1638.4	37.4	325.7	98.1	422.7	13.8	8.71
1640	16.4	153.0	42.8	292.5	20.2	9.35
1640.3	17.2	161.3	12.7	206.3	38.2	9.39
1640.5	13.6	128.5	39.5	341.7	7.5	9.42
1640.55	19.1	186.2	45.3	373.5	8.9	9.75
1641.05	27.5	252.4	51.9	325.5	24.4	9.19
1641.4	19.5	177.1	23.2	218.9	51.2	9.09
1641.8	28.4	268.1	44.9	322.4	15.5	9.44
1642	31.2	304.8	66.5	416.8	4.4	9.77
1642.15	30.7	294.4	67.7	422.7	2.1	9.59
1642.2	19.6	177.7	15.6	306.0	39.3	9.07
1643	19.1	206.8	36.6	359.2	20.4	10.83
1643.3	17.2	162.9	55.8	428.6	1.7	9.49
1643.5	13.4	135.9	10.9	235.3	45.4	10.12
1643.55	14.7	148.6	16.3	195.2	40.4	10.08
1644.3	22.6	225.6	63.1	350.3	5.3	9.97
1644.5	13.5	133.4	16.5	232.6	36.3	9.85
1644.95	13.8	145.9	10.4	207.2	32.0	10.54
1645.4	9.7	81.0	76.6	455.9	3.1	8.35
1645.45	13.6	133.9	16.6	229.8	51.2	9.82
1645.8	27.3	236.8	36.4	257.1	59.6	8.68

Well	16/13A-5					
Sample	Nb	Zr	Y	Sr	Rb	Zr/Nb
2101	21.3	201.7	21.0	289.6	44.1	9.47
2101.5	29.3	257.9	33.0	325.9	37.4	8.80
2101.5	17.3	170.3	20.2	240.6	52.7	9.82
2102.05	10.9	115.8	6.3	290.3	22.6	10.58
2102.25	20.4	161.8	71.9	489.1	9.6	7.94
2102.3	16.1	153.8	15.0	259.2	43.8	9.54
2103.45	25.1	241.6	83.3	354.6	2.5	9.64
2103.8	31.6	315.8	90.3	451.4	1.9	10.01
2103.8	18.2	165.2	11.5	205.6	36.3	9.10
2104.35	13.9	138.2	8.5	146.3	36.0	9.95
2104.85	12.6	131.6	7.3	228.4	32.1	10.47
2106.45	22.7	183.1	14.7	376.6	37.9	8.06
2106.75	25.0	229.0	35.0	406.3	30.5	9.18
2107.5	23.5	225.2	57.4	314.9	16.9	9.57
2107.95	35.2	265.5	31.3	313.5	28.6	7.54
2108.3	32.6	284.5	114.2	388.3	6.1	8.73
2108.5	38.3	345.1	114.1	471.1	2.3	9.02
2108.75	27.4	233.7	27.5	344.1	31.5	8.53
2109.5	24.5	218.0	29.3	323.1	22.6	8.92
2109.9	25.4	213.5	37.3	366.1	20.4	8.42
2110	24.4	229.3	89.0	368.9	6.3	9.42
2110.45	21.9	209.2	42.3	346.7	14.5	9.55
2111.55	23.1	216.8	46.1	385.1	2.9	9.37
2112.4	17.7	170.7	13.8	216.5	28.2	9.62
2112.4	28.0	241.6	28.0	381.5	11.3	8.63
2112.5	10.5	110.2	8.4	149.7	38.5	10.45
2113	11.2	117.3	9.1	228.9	35.2	10.43
2113.4	24.9	220.7	27.4	345.1	12.3	8.88
2113.75	45.8	384.7	64.1	448.9	7.8	8.40
2114.3	25.0	227.9	79.1	353.4	6.1	9.13
2114.35	22.8	208.6	15.9	380.5	24.0	9.14
2115.3	15.0	156.2	17.8	159.3	44.3	10.41
2115.3	27.5	212.9	205.2	421.1	13.0	7.74
2115.35	23.6	237.4	25.6	384.2	6.0	10.04
2115.4	9.9	110.3	13.1	248.0	40.6	11.11
2116	23.7	224.1	15.6	294.9	26.5	9.44
2116	17.5	169.3	8.9	295.8	37.3	9.65
2116.4	36.2	321.1	106.1	437.5	4.3	8.86

Sample	Nb	Zr	Y	Sr	Rb	Zr/Nb
2116.45	17.0	168.0	12.7	308.2	46.4	9.86
2116.8	22.1	201.6	16.7	263.0	30.3	9.12
2117.1	28.2	237.3	100.2	424.6	3.8	8.41
2117.8	20.9	193.5	62.7	408.1	1.8	9.26
2117.85	27.9	264.2	35.5	483.1	12.9	9.47
2118	28.7	249.2	86.2	432.3	3.2	8.68
2118.05	17.9	172.3	12.9	292.9	33.2	9.65
2118.45	12.1	131.1	7.4	226.2	36.0	10.87
2118.5	29.2	274.9	34.1	549.8	3.7	9.40
2118.7	20.0	183.2	52.8	426.0	6.3	9.17
2119.15	12.4	120.0	5.1	195.5	42.6	9.71
2119.15	23.3	187.5	16.2	410.7	7.4	8.03
2119.75	24.4	228.9	60.7	396.3	3.0	9.40
2120	37.7	353.3	34.4	501.7	9.7	9.38
2120.7	25.5	241.1	40.2	400.2	24.6	9.47
2120.9	7.3	97.4	6.6	349.9	4.8	13.37
2121.1	24.8	228.3	56.4	438.2	7.8	9.22
2121.2	11.9	130.4	7.6	359.1	32.5	11.00
2121.7	27.3	252.2	52.9	711.7	9.3	9.24
2122.75	4.5	53.4	5.0	326.9	20.0	11.75
2123.5	18.6	151.8	21.8	371.7	48.5	8.18
2123.5	29.2	143.0	82.4	465.8	8.5	4.89
2124	14.2	128.4	16.4	392.4	35.2	9.05
2125.4	525.6	1711.2	219.8	765.4	11.3	3.26
2125.7	16.8	137.2	13.6	296.5	79.3	8.15

Well	204/19-7					
Sample	Nb	Zr	Y	Sr	Rb	Zr/Nb
2540	7.9	163.3	10.4	285.4	54.2	20.68
2540.5	6.2	151.7	8.0	307.1	44.7	24.58
2540.8	1.9	93.3	2.7	265.4	24.3	48.93
2541	16.7	332.9	18.5	169.4	72.3	19.89
2541.3	12.3	200.6	24.4	185.6	62.3	16.36
2542.3	15.4	228.6	19.0	239.8	63.6	14.83
2542.4	14.0	242.0	25.4	208.8	56.5	17.29
2542.85	15.9	227.8	23.5	247.6	49.4	14.31
2543	14.6	216.3	28.5	213.6	70.9	14.81
2543.6	9.3	100.0	37.5	240.5	9.0	10.73
2544	13.6	180.2	30.3	240.3	49.6	13.27
2544	12.1	220.8	18.5	194.4	64.0	18.30
2544.8	12.6	171.2	27.4	205.3	47.5	13.62
2544.8	12.8	165.7	29.6	191.2	51.7	12.97
2540	10.1	216.0	12.6	153.2	62.4	21.32

Well	204/22-2					
Sample	Nb	Zr	Y	Sr	Rb	Zr/Nb
3704.2	12.7	494.2	17.9	195.3	33.6	39.00
3704.75	14.3	214.3	21.9	214.1	54.9	14.99
3705.25	10.5	168.4	33.0	225.7	33.4	15.98
3705.45	18.8	142.9	19.8	243.8	92.8	7.61
3705.7	20.3	157.3	20.3	258.1	91.3	7.75
3707.75	12.5	251.3	17.0	211.4	52.1	20.16
3708.05	9.6	172.0	15.1	197.8	44.1	17.87
3708.65	10.0	274.7	12.8	197.5	40.3	27.39
3708.7	10.3	186.1	11.5	201.8	48.4	18.01
3708.8	19.5	196.9	15.4	266.2	83.8	10.11
3709	11.2	271.1	21.9	224.4	43.8	24.10
3709.2	16.3	227.4	17.4	260.5	68.0	13.93
3709.45	15.6	338.4	18.4	234.9	60.0	21.67

Well	204/19-3A					
Sample	Nb	Zr	Y	Sr	Rb	Zr/Nb
1974	6.4	112.3	20.6	130.4	29.0	17.66
1975.5	5.0	82.9	23.3	102.9	11.3	16.43
1976	7.9	197.5	14.1	150.2	38.9	25.07
1978.35	11.7	187.4	22.2	146.0	51.7	16.00
1980.85	102.4	554.0	61.7	122.2	39.7	5.41
1980.9	75.1	269.3	36.9	117.8	34.1	3.59
1984	8.2	137.1	22.3	148.2	38.4	16.77
1985.45	5.9	145.8	25.8	148.8	23.5	24.90
1986	10.1	137.1	16.5	109.7	72.0	13.58
1986	5.7	219.5	16.1	171.9	22.8	38.82
1988	4.0	134.3	24.7	143.3	16.1	33.27
1989.3	3.6	102.3	21.8	226.2	18.8	28.17
1989.7	9.3	148.4	20.0	123.5	53.8	15.98
1989.7	9.3	140.3	22.6	140.3	40.6	15.10
1990	5.4	119.8	25.4	147.1	19.2	22.40
1991	4.5	88.5	19.9	105.3	13.4	19.49
1991.3	3.9	86.4	20.3	112.7	10.8	21.94
1991.6	6.2	182.9	21.8	156.7	26.6	29.70
1994	4.9	140.0	26.4	124.3	22.6	28.30
1994.6	7.4	159.2	14.8	128.7	35.1	21.60
1995	7.2	133.0	14.4	134.9	34.4	18.55
1995.1	6.9	153.0	19.7	138.0	36.2	22.29
1995.4	4.5	155.0	23.0	163.6	29.9	34.14
1995.8	9.7	224.9	14.9	146.9	52.9	23.20
1996.3	7.6	170.8	23.0	365.8	40.1	22.56
1996.4	5.7	114.3	15.2	312.1	21.9	20.23
1996.7	5.4	306.5	17.3	157.0	32.2	57.28
1996.7	7.4	160.8	16.4	168.6	31.7	21.82
1999.5	7.1	230.5	24.3	239.7	36.6	32.62

Well 205/16-2

Sample	Nb	Zr	Y	Sr	Rb	Zr/Nb
1980.1	14.3	220.2	17.4	179.9	82.2	15.35
1980.6	14.3	235.6	16.3	174.8	81.0	16.43
1982.5	17.5	185.3	19.5	209.5	85.8	10.60
1986	13.7	171.1	20.5	233.3	68.6	12.46
1986.3	15.4	189.1	22.5	191.2	80.2	12.32
1989.5	9.2	123.9	78.6	268.9	13.1	13.48
1991.3	12.5	166.4	21.2	208.9	63.0	13.29
1993.4	15.5	196.4	24.6	317.1	64.7	12.71
1993.9	13.2	159.0	17.7	269.2	65.7	12.02
1994.4	13.2	187.6	21.0	339.8	57.7	14.18
1994.8	14.6	194.2	20.8	269.8	76.0	13.26
1995.45	16.4	209.2	23.5	256.7	72.9	12.78
1997.8	12.9	174.9	22.4	242.9	62.3	13.53
1998.7	10.4	80.8	87.3	708.1	36.4	7.76
1999.4	21.2	184.6	19.7	164.2	82.9	8.70
1999.5	21.2	217.7	75.2	327.3	15.2	10.26
1999.8	12.9	219.6	19.4	214.9	73.7	16.98
2000.5	13.0	151.2	40.4	237.0	31.8	11.60
2000.8	12.7	194.5	23.3	238.6	47.7	15.29
2001	14.0	216.0	21.0	233.5	61.8	15.38
2001.3	11.9	173.8	19.0	201.0	71.1	14.58
2002.3	12.7	170.9	20.6	226.8	55.7	13.43
2002.9	17.1	180.0	60.7	595.8	5.9	10.54
2003.5	26.8	283.9	50.0	303.2	11.3	10.60
2003.6	12.5	220.0	19.4	204.1	75.0	17.56

sample	material	lab no.	$\delta^{18}O$
B1	lch	5575	7.9
B1	un lch	5576	8.3
BM64	lch	5577	5.5
BM64	un lch	5578	4.7
BM67	lch	5579	4.1
BM67	un lch	5580	3